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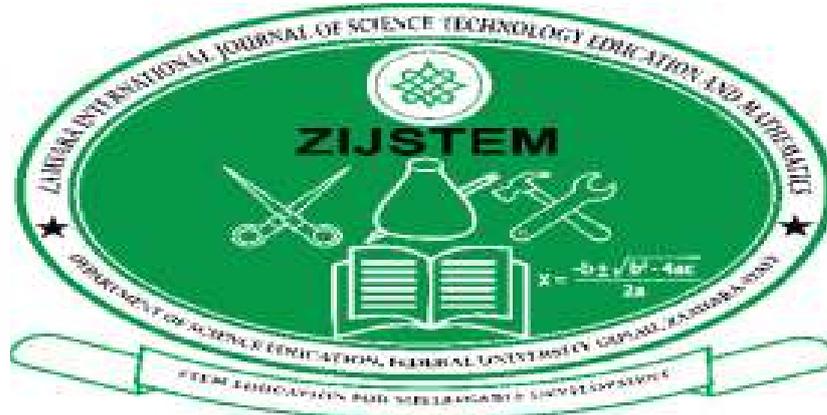


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Zamfara International Journal of Science Technology Education and Mathematics (ZIJTEM) is the official Journal of the Department of Science Education, Faculty of Education Federal University Gusau Zamfara State, Nigeria. The Journal publishes articles 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

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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. M.G. Abubakar, 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,
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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 1, March, 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.

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13. Tables should be in horizontal line only, with only blank space to separate column
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Assessment on Integration of Information and Communication Technology tools for Biology Concepts Teaching among Secondary School Teachers in Zamfara State, Nigeria

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Abstract

This study assessed the Integration of Information and Communication Technology tools for Biology Concepts Teaching among Secondary School Teachers in Zamfara State, Nigeria. The study was guided by four objectives and four research questions. The research design was descriptive survey. The target population of the study was 571 biology teachers from both public and private senior secondary school, out of which 234 respondents were selected using Crejcie and Morgan table to determine the sample size for a known population. The instrument used for data collection was questionnaire which comprises of 29 items including the demographic information of respondents. The instrument was validated by experts and its reliability was 0.73. The research questions were analyzed using descriptive statistics (mean and standard deviation). However, from the analysis of data, it was discovered that biology teachers do not have adequate knowledge of ICT, they also have limited access to ICT, which lead to poor use of ICT tools in schools in Zamfara State. Based on these findings, it was recommended that biology teachers should be sent to seminars, workshops, conference to update their knowledge on how to use ICT facilities in teaching and learning of biology

Keywords: Information and Communication Technology, Biology Concepts, Teachers

Introduction

ICT is any electronic product that stores, retrieves, manipulates, transmits, or receives information in a digital form (Yusuf, Maina, & Dare, 2013). The emergence of these technologies has reduced the world into a global village, and anyone or organization ignoring them is asking to be side tracked and placed on the periphery in the international arena. This new technological age is a revolutionary period whose impact is far surpassing that of the agricultural and industrial revolutions. Information has now become one of the most important tools that have transformed the world economy and changed many facets of life, including education. The Internet, which is one of the many components of ICT, has changed the way we work and interact with each other. The internet has increasingly become an invariable asset in education in terms of learning, teaching, and research (Amuoge and Ejike, 2016).



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Information and Communication Technology (ICT) is made up of diverse technological tools that can be used to communicate, disseminate, store, retrieve, and manage information. The National Teachers' Institute (NTI, 2011) simply defined information and communication technology (ICT) as a means of receiving, processing, storing, retrieving, and disseminating information through the use of computers and other telecommunication facilities. In addition, Gbadebo, Abimbola, Ademi, and Odupe, (2013) see it as a generic term that refers to technologies that are used for collecting, storing, editing, and passing information in various forms.

ICT is an aggregation of technologies vis-à-vis communication facilities that facilitates and helps to improve the nature in which messages are stored, relayed, and disseminated for pre-determined purposes. The use of information and communication technologies has received tremendous attention from both staff and students at Nigerian universities. Therefore, it has become an invaluable tool for learning, teaching, and research in Nigerian universities. It has been widely accepted as a channel through which students and researchers communicate in higher institutions of learning. There has been a positive impact of technological usage on students and researchers in Nigerian universities in their critical thinking, problem solving, and networking. The internet is regarded as one of the most important technological advancements of the 20th century and is anticipated to have a major impact on academic research in the near future. Its power comes from the network's extraordinary global expansion and its capacity to link multiple people and computers together, no matter where they are in the world. The university, as a research institute and a very important body that is relevant to national development, must continue to strive to create a suitable learning environment that will give students room to construct their own knowledge rather than embracing the traditional method. The rapid advancement of digital technologies has positioned the integration of Information Technology and Communication Technology (ICT) as a critical requirement for enhancing pedagogical practices across all educational disciplines (Mugabe, et al, 2023). According to Adebayo et al, (2022) integration of ICT is important as the biology deals with abstract, microscopic or dynamic concepts that are that difficult to visualize and experiment with traditional settings. In other word, modern educational policy increasingly encourage teachers to adopt ICT tools, such as multimedia, interactive simulations and Virtual Laboratories (VLs) to foster student engagement and improve learning outcomes.

The prevailing view among secondary school biology teachers is positive regarding the potential of ICT as a powerful instructional tool capable of making lessons more interesting, enhancing conceptual understanding and facilitating a collaborative, student-centered learning environment (Adebayo et al, 2022; Niyitanga, 2024). Afolabi, (2024) said teachers generally express a high level of self-efficacy and willingness to adopt these technologies, indicating a readiness for pedagogical change. Despite the strong and optimistic perception of ICT's pedagogical benefits, the level of integration remains a problem in many secondary schools. Ibrahim et al, (2024) observed that empirical evidence reveals a profound dichotomy between teachers' positive attitudes and their limited practical utilization. The successful implementation of ICT is obstructed by barriers; the most significant challenges cited by teachers include lack of adequate ICT infrastructure and internet connectivity, coupled with the absence of continuous in-training services focusing on the pedagogical integration of technology (Mugabe et al, 2023; Niyitanga, 2024). As a result, some teachers demonstrate a tendency to rely on conventional methods of teaching, partly due to the extra time required to learn, prepare and manage ICT – based lessons and the difficulty of controlling the class when using technology.



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Statement of the Problem

Zamfara State has been facing a massive failure in West African Examination Council (WAEC) and National Examination Council (NECO) results, and biology being one of the five basic subjects that a student must acquire before getting admission into tertiary institution to study science courses. From the data collected from WAEC Chief Examiner's report in 2016, 50.0% students passed biology, while in 2017, 50.0% passed but in 2018, 47.0% students passed biology, and in 2019, 48.7% passed while in 2020, 49.0% students passed biology.

WAEC Biology Performance: Credit Pass Rate (2016 – 2020)

Year	Total % of candidates with credit pass (A1-C6) in Biology	Implied percentage of failure below credit (D7-F9)
2020	49.0%	51.0%
2019	48.7%	51.3%
2018	47.0%	53.0%
2017	50.0%	50.0%
2016	50.0%	50.0%

Source: Field work, 2024

Based on the above, these percentages show that, on average, over this five-year period, half of the students who took the WAEC Biology examination failed. This led the researchers to carry out an assessment on Integration of Information and Communication Technology tools for Biology Concepts Teaching among Secondary School Teachers in Zamfara State, Nigeria.

Objectives of the study

The objectives of the study are as follows:

1. To find out the level of knowledge of biology teachers in ICT in secondary schools in Zamfara State
2. To find out the accessibility of biology teachers on ICT in secondary schools in Zamfara State
3. To find the difference in level of knowledge of ICT between public and private school

biology teachers in secondary schools in Zamfara State

4. To find the difference in the view of public and private school biology teachers on ICT accessibility in secondary schools in Zamfara State

Research questions

The following questions are raised to guide in carrying out this study.

1. Does the biology teachers have adequate knowledge of ICT in secondary schools in Zamfara State?
2. What is the level of accessibility of biology teachers on ICT in secondary schools in Zamfara State?
3. What is the difference in the level of knowledge of ICT between public and private school biology teachers in secondary schools in Zamfara State?
4. What is the difference in the view of public and private school biology teachers on ICT accessibility in secondary schools in Zamfara State?

Methodology



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This study used a descriptive survey method. This study is aimed at finding out the view of senior secondary school teachers on the use of information and communication technology (ICT) in teaching and learning of biology in Zamfara State of Nigeria. The population of this study consisted of all biology teachers teaching in both public and private senior secondary schools in Zamfara State. The population therefore comprises of 571 biology teachers from which 394 teachers are from public secondary schools and 177 teachers are from private secondary schools. This makes a total of 571 target population. Sampling makes it possible to draw valid inferences or generalization on the basis of careful observation of variables with a relatively small proportion of the population (Best and Khan, 2008). In this study only 234 teachers were sampled following krejcie and Morgan (1970) table of determining sample size of a known population in which 150 teachers are from public secondary schools and 84 teachers from private secondary schools. The choice of the school was purposive in as much as they had computers used for instructional purposes. This study investigates the teachers view on the use of information and communication technology in teaching and learning of biology. The instrument used in the collection of data is questionnaire. The questionnaire was designed by the researcher which consisted of two sections; section A demographic information which consisted of sex and types of school and section B contained 3 items with regard to research objectives.

Validity and Reliability of the instrument

The face validity was ascertained by two senior lecturers from Department of Science Education Federal University Gusau, Zamfara State. The terms of reference for the validation are to assess whether (a) the test items were in line with the subject matters they were supposed to test (b) the language of expression was simple and clear and to make sure if it contains the element needed to address the subject to study. The reliability of the instrument was determined through a pilot study with test-re-test method after administering the questionnaire to 20 respondents and was re-administered again after the interval of two weeks. The researcher personally visited all the selected schools to administer and collect the questionnaire on the spot to avoid loss of questionnaire. However not a single one was missing which gave a 100% return rate of 234 questionnaire. The data collection was analyzed using mean and standard deviation (descriptive statistics). Any mean response of 2.50 and above was considered positive (Agree) while any mean response below 2.50 was considered negative (Disagree) and t-test statistics was used to test the null hypotheses.

Presentation of Results

Answering of research questions

Research question 1: Does biology teachers have adequate knowledge of ICT in secondary schools in Zamfara State?

Table 1: level of knowledge of biology teachers

S/N	ITEMS STATEMENT	N	Mean	Decision
1	I know how to operate a computer/laptop	234	2.05	Rejected
2	I know how to operate a tablet/mobile device	234	3.05	Accepted
3	I can design products that are students centered by using ICT	234	1.51	Rejected
4	I know how to operate multimedia projectors	234	1.85	Rejected
5	I can use ICT to teach topics of biology that are better learned when employing specific teaching approaches	234	3.05	Accepted



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6	I can use strategies that combine biological content ICT are teaching approaches to support students understanding as they are learning biology	234	2.58	Accepted
7	I can use ICT to teach student to develop their biological problem solving through inquiry-based learning	234	2.58	Accepted
8	I can use ICT in teaching by employing direct instruction	234	1.87	Rejected
Average means score				

2.31

Source: Field work, 2024

Table 1 present the analysis of data on level of knowledge of biology teachers on ICT. Analysis reveals that items 2,5,6 and 7 had mean a score of above 2.50 while item 1,3,4 and 8`had a mean score below 2.50 the result indicated an average mean of 2.31 which shows that biology teachers does not have adequate knowledge of ICT in Zamfara state

Research question 2: What is the level of ICT accessibility of biology teachers in secondary schools in Zamfara State?

Table 2 ICT Accessibility of biology teachers

S/N	ITEMS STATEMENT	N	X	Decision
9	I used ICT laboratory once in a week	234	3.61	Accepted
10	I used ICT laboratory twice in a week	234	2.63	Accepted
11	I used ICT laboratory almost everyday	234	1.81	Rejected
12	I have personal computer at home	234	1.20	Rejected
13	We have personal computer in our office	234	2.21	Rejected
14	We have 24 hours power supply in my school	234	2.01	Rejected
15	We have 3G/4G network in our school	234	2.26	rejected
16	I can log in anytime with my device at the comfort of my home	234	2.00	Rejected
17	I can log in only when I am in the school premises	234	2.50	Accepted
Average mean score				2.30

Source: field work 2024

Table 2 shows that the analysis of data on the ICT accessibility of biology teachers. The table shows that item (9, 10 & 17) had a means score above 2.50, this indicated that biology teachers used ICT laboratory once in a week and they can only login when they are in the school premises while items 11,12 and 14 were rejected with a mean below 2.50 and an average mean of 2.30 which shows that biology teachers has limited access to ICT due to poor power supply.

Research question 3: What is the difference in the level of knowledge of ICT between public and private school biology teachers in secondary schools in Zamfara State?

Table 3: The difference in the level of knowledge of ICT between public and private school biology teachers

S/N	Type of school	Mean	Standard deviation
1	Public	2.12	0.354
2	Private	2.50	0.535

Source: field work, 2024



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Table 3 shows that public teachers have a mean of 2.12 with a standard deviation of 0.354 while private school teachers have a mean of 2.50 with a standard deviation of 0.535 and a mean difference of 0.38 which shows that the level of ICT knowledge private school biology teachers was higher than the public-school biology teachers.

Research question 4: What is the difference in the view of public and private school biology teachers on ICT accessibility in secondary schools in Zamfara State?

Table 4: The difference in the view of public and private school teachers on ICT accessibility

S/N	Type of school	Mean	Standard deviation
1	Public	2.22	0.21
2	Private	2.78	0.44

Source: Field work, 2024

Table 1.4 shows that the view of public and private biology teachers on ICT accessibility is 2.22 and 2.78 respectively with a mean difference of 0.56 which means that private school biology teachers have more ICT accessibility than the public school biology teachers.

Discussion of findings

The findings of this research corroborated with that of Olawale and Yusuf, (2023) who confirmed that availability and utilization of ICT for teaching biology is low, it also agreed the study of Osawuru, (2024) who said teachers had a strong desire to integrate ICT but faced challenges like limited ICT tools, poor internet, power issues and lack of training/technical support. Some studies point to the lack of electrical outlets in classrooms as a practical constraint (Rubach and Lacarides, 2021).

Conclusion

Based on the findings, it can be concluded that the majority factors that lead to failure of students in biology after integrating ICT in teaching and learning in Zamfara State are inadequate knowledge of ICT by biology teachers, also biology teachers have limited access to ICT to the extent that most their lectures and practical are done once or twice a week and this will hinder the teachers in helping students to communicate, share ideas and work as a team anywhere, anytime such as teleconferencing where students around the world are limited to meet together for a discussion related to a specific topic. Therefore, Teachers are expected to be trained on how to utilize ICT facilities in teaching and learning of biology, thus, make students to learn on their own as now the world is heading towards paperless society.

Recommendation

Based on the finding of the study the following recommendation one made

1. Biology teachers should be sent to seminars, workshops, conference to update their knowledge on how to use ICT facilities in teaching and learning of biology
2. Adequate ICT tools should be provided for biology teachers so as to have engaging classrooms where there will be meaningful learning.
3. Biology Teachers should be retrained on how to use various methods and techniques of teaching biology using ICT facilities.
4. Biology teachers should also create time to learn about ICT on their own.

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Conceptual Analysis of Organizational Citizenship Behaviour as a Driver of Workplace Productivity in Nigeria

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Abstract

Organizational Citizenship Behaviour (OCB) is a crucial yet often underrecognized contributor to workplace productivity. This conceptual study examines how voluntary employee behaviours, such as altruism, conscientiousness, courtesy, sportsmanship, and civic virtue, enhance individual performance, team cohesion, and overall organizational effectiveness. Grounded in Social Exchange Theory and Organizational Support Theory, the paper explains how OCB emerges from personal attributes, leadership styles, organizational culture, and social dynamics. The study distinguishes between OCB directed toward individuals (OCB-I) and the organization (OCB-O), illustrating how each supports innovation, cooperation, efficiency, and positive work climates. While the benefits of OCB are substantial, the study also acknowledges its potential drawbacks, including burnout, role ambiguity, and the exploitation of highly committed employees. Through critical analysis, the study identifies ethical leadership, supportive HRM practices, clear job boundaries, and healthy work environments as essential mechanisms for cultivating OCB sustainably. Based on these insights, the study recommends strengthening ethical and transformational leadership, integrating OCB-supportive practices into recruitment and employee development, and promoting psychological safety to prevent overload. It also emphasizes the importance of context, urging organizations to adopt culturally sensitive approaches that respect the voluntary nature of OCB. Given its conceptual nature, the study calls for future empirical research, particularly mixed-method and longitudinal investigations, to quantify OCB's effects across sectors and cultural settings. Overall, the study concludes that when managed ethically, OCB serves as a strategic, human-centred catalyst for organizational development and long-term productivity.

Keywords: Organization, Citizenship Behaviour & Workplace Productivity

Introduction

Enhancing workplace productivity through organizational citizenship behaviour involves fostering voluntary, positive employee actions that go beyond formal job requirements to support organizational effectiveness and a collaborative work environment. Organizational Citizenship Behaviour (OCB) refers to discretionary employee behaviours that are not directly recognized by formal reward systems but collectively contribute to the effective functioning of an organization (Organ, 1988). These behaviours include actions such as helping colleagues, being punctual, volunteering for extra work, and promoting a positive work environment. Over time, OCB has evolved as a critical aspect of organizational effectiveness, especially in knowledge-based and service-driven economies (Podsakoff, MacKenzie, & Podsakoff, 2018).

Workplace productivity, on the other hand, denotes the efficiency with which organizational resources, particularly human capital, are utilized to achieve goals and deliver outcomes (Organisation for Economic Co-operation and Development (OECD), 2020). It encompasses both the quantity and quality of output relative to inputs, influenced by individual performance, teamwork, and organizational systems. The interplay between OCB and workplace productivity has attracted growing scholarly and practical attention. With increasing competition and the shift towards more collaborative, flexible work cultures, organizations are relying more on employees' willingness to go beyond formal job requirements (Chughtai, Byrne, & Flood, 2021). This discretionary effort can serve



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as a catalyst for improved morale, enhanced cooperation, and ultimately, increased productivity. However, despite the recognized value of OCB, many organizations struggle to understand how to cultivate and sustain it without formal mechanisms or incentives. The central problem addressed in this study is the limited practical understanding of how OCB can be systematically promoted to enhance productivity, particularly in diverse organizational contexts. The primary objective is to critically explore the relationship between OCB and workplace productivity, identify key drivers and barriers, and recommend effective strategies for leveraging OCB for organizational performance improvement. This paper is structured into eight interconnected sections: the introduction, theoretical frameworks, types of OCB, determinants of OCB, the impact on productivity, strategies to promote OCB, challenges and limitations, and a concluding synthesis with recommendations.

Theoretical Framework and Models of Organizational Citizenship Behaviour

Organizational Citizenship Behaviour (OCB) is grounded in several theoretical frameworks that explain why employees engage in behaviours that go beyond formal job requirements. Two of the most influential theories in this area are Social Exchange Theory (SET) and Organizational Support Theory (OST). Social Exchange Theory, as proposed by Blau (1964), posits that human relationships are formed through a process of cost-benefit analysis and reciprocal exchanges. In the workplace context, when employees perceive that they are treated fairly and supported by their employers, they are more likely to reciprocate with positive behaviours such as OCB. This reciprocity is not contractual but discretionary, making OCB a natural response to perceived organizational benevolence (Cropanzano & Mitchell, 2005).

Organizational Support Theory (Eisenberger et al., 1986) builds on SET by focusing on employees' perception of how much the organization values their contributions and cares about their well-being, termed Perceived Organizational Support (POS). High POS has been positively correlated with increased OCB because employees feel emotionally obligated to contribute to organizational success (Rhoades & Eisenberger, 2002). Thus, both theories highlight the importance of trust, fairness, and support in fostering OCB. Organ (1988), the pioneer of OCB conceptualization, identified five core dimensions of OCB: altruism, conscientiousness, sportsmanship, courtesy, and civic virtue. Altruism involves helping colleagues with tasks or problems, while conscientiousness refers to exceeding minimum role requirements responsibly. Sportsmanship reflects maintaining a positive attitude even in adversity. Courtesy is about preventing work-related conflicts through consideration, and civic virtue refers to actively participating in organizational governance and staying informed. These dimensions reflect the multifaceted nature of OCB, encompassing both interpersonal (OCB-I) and organizational (OCB-O) directed behaviours (Williams & Anderson, 1991). The integration of SET and OST into these dimensions provides a strong theoretical basis for understanding how workplace behaviours emerge and evolve. For instance, employees who feel respected and supported (OST) are more likely to demonstrate courtesy and altruism. Likewise, those engaged in social exchanges marked by fairness and mutual respect (SET) may exhibit conscientiousness and civic virtue as expressions of loyalty and commitment. In summary, the theoretical frameworks of OCB not only explain its emergence but also guide organizational strategies aimed at enhancing employee commitment and productivity. Recognizing the psychological underpinnings of these behaviours enables managers to foster environments that encourage sustainable, voluntary, and productivity-enhancing actions.

Components and Types of Organizational Citizenship Behaviour

Organizational Citizenship Behaviour (OCB) encompasses a range of discretionary behaviours that support the social and psychological environment of the workplace but are not formally recognized



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by reward systems. Organ (1988) initially categorized OCB into five dimensions: altruism, conscientiousness, sportsmanship, courtesy, and civic virtue. These dimensions provide a comprehensive framework for understanding the different ways employees contribute beyond their prescribed roles. Altruism refers to voluntary behaviours aimed at helping others with work-related problems, such as assisting a colleague with a heavy workload or offering guidance to a new employee. Conscientiousness reflects an employee's diligence and commitment to exceeding basic job expectations, often seen in consistent punctuality, adherence to organizational rules, and sustained effort without supervision. Sportsmanship involves the ability to tolerate inconveniences and setbacks without complaining, thereby maintaining group morale. Courtesy pertains to proactive actions that prevent work-related conflicts, such as informing co-workers before making decisions that affect them. Civic virtue signifies responsible participation in the life of the organization, including attending meetings, staying informed about company policies, and engaging in constructive dialogue about organizational improvement (Organ, 1997).

These behaviours are typically divided into two main categories: OCB-Individual (OCB-I) and OCB-Organization (OCB-O). OCB-I includes altruism and courtesy, which are directed towards specific individuals within the organization. These behaviours enhance interpersonal relationships and promote cooperation among employees. In contrast, OCB-O includes conscientiousness, sportsmanship, and civic virtue, which are directed toward the organization as a whole. These behaviours support organizational functioning by reinforcing norms, systems, and a positive organizational image (Williams & Anderson, 1991). In practice, these behaviours can manifest in various organizational settings. For instance, in a healthcare environment, a nurse who volunteers to take on additional shifts to help understaffed colleagues exhibits altruism, while a software engineer who attends optional planning meetings to contribute to organizational strategy demonstrates civic virtue. These actions, though not mandated, contribute significantly to team cohesion, service quality, and overall productivity. Recognizing and encouraging OCB in organizational contexts is essential because such behaviours often fill gaps left by formal structures, especially in dynamic and team-based work environments. Managers who understand and nurture both OCB-I and OCB-O can build resilient and high-performing organizations.

Determinants of Organizational Citizenship Behaviour

Organizational Citizenship Behaviour (OCB) is shaped by a complex interplay of personal, organizational, and social factors that influence whether and how employees choose to go beyond their formal job descriptions. Understanding these determinants is critical for managers and organizations aiming to foster environments that enhance workplace productivity through OCB. Personal factors such as job satisfaction, personality traits, and organizational commitment significantly influence OCB. Job satisfaction, for instance, is consistently linked to higher levels of OCB, as satisfied employees are more likely to engage in voluntary actions that benefit their co-workers and the organization (Organ & Ryan, 1995). Personality traits, particularly those related to the Big Five model-agreeableness, conscientiousness, and extraversion-have been positively associated with OCB (Podsakoff et al., 2000). Employees with these traits are naturally inclined to help others and perform beyond expectations. Moreover, affective commitment, which reflects an emotional attachment to the organization, has been found to predict OCB more strongly than normative or continuance commitment, as emotionally invested employees are more likely to engage in discretionary behaviours (Meyer et al., 2002). Organizational factors also play a crucial role. Leadership style, especially transformational leadership, has been identified as a major driver of OCB. Transformational leaders inspire, motivate, and support their subordinates, encouraging them



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to go beyond role requirements (Podsakoff et al., 1996). Organizational culture that promotes trust, mutual respect, and open communication similarly fosters OCB by creating an environment where employees feel psychologically safe to engage in extra-role behaviour. Additionally, perceptions of organizational justice, such as distributive, procedural, and interactional fairness, strongly influence OCB. When employees believe they are treated fairly, they reciprocate through loyalty and helpfulness (Colquitt et al., 2001). Social factors, particularly team cohesion and peer relationships, further determine the likelihood of OCB. Strong interpersonal relationships and a sense of belonging within teams encourage cooperative behaviours. When peers support and recognize each other, individuals are more inclined to act in the group's interest, even at a personal cost (Chiaburu & Harrison, 2008). Positive peer norms and informal social rewards also reinforce OCB as desirable behaviour within workgroups. Altogether, these determinants underscore the multifactorial nature of OCB. Managers seeking to cultivate such behaviour must take a holistic approach, aligning individual, organizational, and social factors to create an enabling environment where OCB can thrive and, in turn, enhance productivity and organizational effectiveness.

Impact of OCB on Workplace Productivity

Organizational Citizenship Behaviour (OCB) plays a vital role in enhancing workplace productivity by positively influencing individual, team, and organizational performance. Although OCB is not formally recognized in job descriptions, it fosters an environment of collaboration, efficiency, and adaptability—elements that are crucial for sustainable productivity. At the individual level, employees who exhibit OCB tend to support their colleagues, engage proactively with their work, and exhibit a higher level of task ownership. These behaviours improve job performance by reducing workload bottlenecks, increasing task interdependence efficiency, and encouraging knowledge sharing (Podsakoff et al., 2009). For example, altruistic acts such as mentoring or aiding co-workers not only accelerate task completion but also elevate the collective skill level of the team. Civic virtue enhances strategic alignment as employees who stay informed and involved in organizational matters often contribute constructively to decision-making processes. Team performance is also enhanced by OCB through improved cooperation, conflict resolution, and morale. When team members exhibit courtesy and sportsmanship, interpersonal tensions are minimized, thereby fostering psychological safety and open communication (Somech & Drach-Zahavy, 2004). This creates an atmosphere where ideas can be freely exchanged, leading to innovation and creative problem-solving. Team cohesion, nurtured by mutual respect and voluntary support, further facilitates synchronized workflow and shared responsibility for outcomes.

OCB also has a direct impact on broader organizational outcomes such as operational efficiency, adaptability, and innovation. For instance, conscientious employees help maintain consistent standards without the need for constant supervision, reducing management overhead and promoting self-regulation (Turnipseed & Rassuli, 2005). Moreover, organizations with high levels of OCB experience enhanced morale and reduced turnover, as employees perceive a positive work climate and greater organizational justice. This leads to a more stable and engaged workforce, which is essential for long-term productivity. Empirical studies substantiate the link between OCB and productivity. Podsakoff et al. (2009), in a meta-analytic review, found that OCB is significantly correlated with performance ratings, profitability, efficiency, and customer satisfaction. Similarly, a study by Walz and Niehoff (2000) in a service organization revealed that departments with higher levels of OCB had significantly better customer evaluations and financial outcomes. In healthcare settings, OCB has been linked to reduced errors and improved patient satisfaction, demonstrating its cross-sector relevance (Mackenzie et al., 2011). OCB acts as an informal mechanism that fills



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structural gaps in organizations by encouraging voluntary behaviours that promote efficiency, innovation, and cooperative culture. Cultivating OCB is not just a moral or cultural imperative, it is a strategic tool that directly contributes to workplace productivity and competitive advantage.

Strategies for Promoting Organizational Citizenship Behaviour

Promoting Organizational Citizenship Behaviour (OCB) requires deliberate and strategic organizational efforts, particularly through leadership engagement, supportive human resource (HR) practices, and an environment that reinforces pro-social behaviour. Since OCB is discretionary and not formally rewarded, encouraging its development demands a nuanced approach that aligns employee motivation with organizational goals. Leadership plays a central role in fostering OCB. Transformational leaders, who inspire and motivate employees through vision and individualized consideration, are especially effective in promoting OCB. These leaders cultivate trust, model altruistic behaviour, and instil a sense of collective purpose, thereby encouraging employees to transcend formal role expectations (Podsakoff et al., 2000). Ethical leadership is also pivotal; leaders who demonstrate fairness, integrity, and concern for others promote a culture where employees feel safe and valued, increasing their willingness to engage in voluntary, cooperative behaviours (Brown & Treviño, 2006).

HR practices that align with employee needs and values significantly enhance OCB. Recruitment and selection processes can prioritize candidates with high levels of agreeableness and conscientiousness—traits associated with OCB (Organ & Ryan, 1995). Additionally, creating a high-commitment work system, where employees perceive organizational support through job security, training, and participative decision-making, fosters a reciprocal relationship that naturally encourages citizenship behaviour (Paillé et al., 2010). Although OCB is not formally rewarded, indirect incentivization can be achieved through recognition and intrinsic motivators. Public praise, peer acknowledgment, and inclusion in decision-making processes validate employees' contributions, reinforcing positive behaviour without undermining its voluntary nature. According to Bolino and Turnley (2003), non-monetary recognition such as employee of the month awards or internal communication shout-outs can strengthen perceptions of fairness and appreciation, leading to sustained OCB. Training and feedback are additional mechanisms for promoting OCB. Workshops and seminars focused on team collaboration, emotional intelligence, and conflict resolution build behavioural competencies aligned with OCB dimensions like courtesy and sportsmanship (Rioux & Penner, 2001). Furthermore, regular feedback and coaching, especially from supervisors, can shape employees' awareness of their impact on team dynamics, guiding them toward more constructive discretionary behaviours. Ultimately, promoting OCB requires a multifaceted strategy that goes beyond compliance and taps into employees' intrinsic motivation. By fostering a supportive culture, modelling desired behaviours, and reinforcing contributions informally, organizations can create a thriving environment where OCB is both valued and widespread.

Challenges and Limitations in Promoting OCB for Productivity Gains

While Organizational Citizenship Behaviour (OCB) is widely acknowledged for enhancing workplace productivity, promoting it is not without challenges. Several limitations may hinder its effectiveness, especially when organizations fail to balance encouragement with ethical responsibility and contextual awareness. One major challenge is the risk of exploitation and employee burnout. Because OCB consists of discretionary behaviours not formally recognized or compensated, some employees may feel compelled to consistently go beyond their formal roles to gain favour or maintain job security. This can lead to emotional exhaustion, work-life imbalance, and long-term disengagement (Vigoda-Gadot, 2006). For instance, Bolino et al. (2010) found that employees high



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in citizenship behaviours often experience role overload, especially in high-pressure environments where such behaviours are expected rather than voluntary. This undermines well-being and can paradoxically reduce overall productivity. Cultural and contextual limitations also constrain the universal application of OCB. In collectivist cultures, for example, OCB may be perceived as a group norm, and thus not as an individual choice, diminishing its motivational value (Farh et al., 2007). In contrast, in individualistic cultures, such behaviours may be more voluntary and thus more meaningful. Additionally, industries or work environments that prioritize rigid hierarchies or highly standardized processes may find it difficult to accommodate the fluidity that OCB requires. Another important challenge is balancing formal role performance with extra-role behaviours. Employees who over-prioritize OCB may neglect core job responsibilities, especially when OCB is not strategically aligned with organizational goals. As noted by Bergeron (2007), while helping behaviours can foster social capital, they can also distract from key performance indicators if not properly managed. Managers must therefore ensure that OCB supplements, rather than supplants, formal role execution. To overcome these challenges, organizations must foster a culture of psychological safety, provide clear expectations, and avoid pressuring employees into constant extra-role performance. Ethical leadership, supportive HR systems, and awareness of contextual dynamics are essential for maximizing OCB's benefits without compromising employee well-being or organizational integrity.

Recommendations

To translate the benefits of Organizational Citizenship Behaviour (OCB) into measurable productivity gains, organizations must move beyond theory into practical, evidence-based strategies. The following recommendations aim to guide managers, policy-makers, and researchers in fostering, managing, and further investigating OCB within diverse workplace contexts:

I. Strengthen Ethical and Transformational Leadership

Leadership that is ethical and transformational fosters trust, models citizenship behaviour, and encourages voluntary employee contributions. Leaders should be trained to exhibit fairness, openness, and inspirational motivation to organically encourage OCB (Brown & Treviño, 2006; Podsakoff et al., 2000).

II. Integrate OCB into HRM Practices

Recruitment processes should assess for citizenship-oriented traits like conscientiousness and agreeableness. HR should reinforce OCB through informal recognition, inclusive culture, and employee development programmes without formalizing or overburdening it (Organ & Ryan, 1995; Bolino & Turnley, 2003).

III. Promote a Healthy Work Environment

To avoid burnout and role overload, organizations must establish clear job boundaries, ensure psychological safety, and support work-life balance. Voluntary behaviours should not substitute for core job roles or be implicitly required (Vigoda-Gadot, 2006).

IV. Encourage Empirical and Contextual Research

Since this study is theoretical, future empirical research should explore how different forms of OCB impact productivity across sectors and cultures. Mixed-method and longitudinal studies can provide a deeper understanding of the mechanisms, outcomes, and limitations of OCB in diverse settings (Farh et al., 2007).

Conclusion

This study critically examined the role of Organizational Citizenship Behaviour (OCB) in enhancing workplace productivity. It established that when employees voluntarily engage in extra-role behaviours, such as altruism, conscientiousness, and civic virtue, they contribute significantly to



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organizational efficiency, innovation, and morale. The discourse highlighted key theories underpinning OCB, identified its dimensions and determinants, and analyzed its positive and negative impacts on productivity. Although challenges like burnout and contextual limitations exist, strategic HR practices and ethical leadership can mitigate these risks. By promoting a supportive work environment and encouraging voluntary commitment, organizations can unlock the full potential of OCB as a sustainable driver of performance and long-term productivity.

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Comparative assessment on Availability of Social Amenities and 9-Year Basic Education Curriculum implementation among public Primary Schools in North-West, Nigeria

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Abstract

This was on availability of social amenities in school location as correlate to effective implementation of 9-year Basic Education Curriculum in North-West, Nigeria. The study was guided by two objectives, research question and hypothesis. The target population for this study was 9,728 teachers and 1,187 public primary school in Kebbi, Sokoto and Zamfara States. Multi-stage sampling techniques was adopted and Simple random sampling technique was used in selecting states, Local Governments, public primary schools and Education Zones. The Study sample was 370 using research advisers 2006. Two sets of researcher-made instruments were used namely: Availability of Social Amenities in School Location Rating Scale (ASSLRS) and Basic Education Curriculum Implementation Questionnaire (BECIQ). Data collected were analysed using statistical package for Social Sciences (SPSS) version 20. Mean and standard deviation was used to respond to research question and Pearson Product Moment Correlation coefficient was used to analyse the null hypothesis. The result revealed that, teachers in schools located with available social amenities were more effective in implementing the Basic Education Curriculum in North-west Nigeria. Based on the finding, it was recommended that Governments, schools, and community members should collaborate to provide social amenities, for implementation of Curriculum in Public Primary Schools.

Key words: School Location, Social amenities, Curriculum Implementation and 9-year Basic Education

Introduction

School serves as a social and learning agent, providing the environment for formal education to help children achieve educational goals. The availability of social amenities in the school locality is a crucial consideration in choosing a school location. The availability of social amenities plays a fundamental role in the effective implementation of the primary school curriculum. The universal basic education (UBE) Programme in Nigeria, aim at ensuring access to quality education for all children, however, disparities in the provision of basic social amenities across urban and rural schools continue to affect curriculum delivery. The availability of these facilities determines not only the quality of instruction but also teachers' effective implementations, pupil's attendance and overall learning outcomes (Ibrahim, 2024) The selected site should have essential facilities, including health care services, commercial services, a police station, banking services, a market, firefighting services, and postal and telecommunication services. Health care services, such as hospitals, dispensaries,



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clinics, or pharmacies, along with other health facilities capable of providing emergency care to pupils and staff, should be available. The absence of health services in the locality could jeopardize the lives of the school community members (Ibrahim, 2009).

Social amenities refer to the basic physical and social infrastructure that improve the living and working conditions of individuals within school community. Basic schools are located in urban, semi-urban, and rural areas. Manga (2016) assert that, regardless of the location, there is a need for data to rationalize and draw up plans for both urban and rural schools. The data include physical aspects, site details, building type, usage, capacity among others. The data are also essential in ensuring effective implementation of the curriculum. The effectiveness of teachers in implementing the curriculum depends on several factors, one of which is school-related factors, and school location is one of the factors influencing the distribution of educational resources. According to kuliman (2015), unsuitable school locations have contributed to imbalances in basic education delivery across different parts of the country (Adebayo, Daniel, and Oladipupo, 2018). Lipton (2017) affirmed that rural communities are marked by low population, subsistence lifestyles, and monotony, while urban environments feature amenities such as hotels, recreational centers, markets, banks, schools and good road networks. Additionally, Owolabi (2016) emphasized that highly qualified teachers prefer to serve in urban areas rather than rural ones as a result of presence of basic social amenities. As a result, Kuliman (2015) observed that teachers often resist postings to rural areas due to substandard conditions, restricted social life, inadequate amenities, deficient facilities, lack of playground equipment, absence of books in libraries, and under-equipped laboratories. Manga (2016) sees school location as the actual site of a school, and the location of a school is crucial to the accomplishment of school objectives through the effective implementation of the curriculum. The school location factors whether located in rural, urban, or semi-urban areas, must be considered in planning for school location, the factors including centrality, noise levels, social amenities, land size, pollution, flood risk, and proximity to highways, among others. These are essential for ensuring that basic education teachers effectively cope with the implementation of the 9-year Basic Education Curriculum (BEC).

Social amenities in schools according to Githaka, Gachahi and Mwaruvie (2019) Social amenities in primary schools play an important role in the provision of quality education. Social amenities include play materials and sanitation facilities. The school should be centrally located within the locality of its construction, ensuring that children in primary schools do not walk more than four kilometers and those in secondary schools do not walk more than six kilometers to or from school daily. Catchment area for rural Primary schools, with at least 25-250 pupils justifies the construction of a school facility, while urban primary schools should have at least 250-510 pupils. Secondary schools require 240-1200 students to justify establishment (FME, 2010). Locating the school in an area with a low population may result in underutilization of resources, while a high-density population may lead to overutilization of resources (Ibrahim, 2024). Similarly, Musibau and Johnson (2010) asserts that the school's locality should have a daily market where people can purchase daily foodstuffs and other necessities. In cases where a village only has a weekly market, teachers may be compelled to travel far from town to shop for their daily needs, impacting teacher posting and retention in the school. Moreover, the locality should have at least one bank where staff and students can deposit or withdraw money to meet their daily needs and other critical requirements. The lack of banking services can create financial insecurity, forcing staff to travel to town during school hours to handle monetary transactions. Additionally, the availability of postal and communication network



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services is crucial in today's age of mobile phones. Teachers and students prefer environments with mobile network coverage, and having internet facilities and other information technology services can be beneficial for research work (Manga, 2016). Lastly, the community should have firefighting equipment to respond to incidents of fire outbreaks. The availability of the described social amenities will contribute to the effective implementation of the curriculum.

The 1999 Universal Basic Education (UBE) program, which focuses on basic education and was passed into law in 2004, upholds the constitutional responsibilities of governments at all levels to finance and manage basic education. Therefore, there is a need for a revised policy on education to properly implement UBE and achieve the goals of basic education. The proposed policy was passed alongside the UBE Act and other related matters in 2004. It underwent a review in 2013 to accommodate national and global initiatives of government reform agendas such as Sustainable Development Goals (SDGs) and the National Economic Empowerment and Development Strategy (NEEDS). This document initiative emphasizes value re-orientation, poverty reduction, job creation, wealth generation, and using education to empower people. The curriculum must, therefore, be reviewed and realigned to accommodate the objectives. These commendable ideals can only be achieved by closing the gaps between the National Primary Education Curriculum (NPEC) and the new curriculum contents of the 9-year Basic Education Curriculum BEC (Primary). The curriculum was developed in 2006 by the Nigerian Educational Research and Development Council (NERDC) and was implemented nationwide in 2008. The nine-year Basic Education Curriculum (BEC) was reviewed in 2012 to streamline the number of subjects by aligning similar ones. For instance, Basic Science and Technology (BST) encompassing Basic Science, Information Communication Technology (ICT), Basic Technology, Physical and Health Education (PHE), etc., were integrated as one entity (UBE, 2008). The effective and efficient implementation of the Basic Education Curriculum (BEC) in Nigeria, is contingent on the provision of quality teachers and an adequate number of school locations with necessary facilities, social amenities and a conducive learning environment. Adepoju, (2013) highlighted certain factors as responsible for low effectiveness in schools which include poor school location, lack of social amenities in school location, infrastructural facilities, poverty; frequent changes in education policies by the government, among others. Currently the school location in North-west faced with inadequate provision of social amenities among others as a result of banditry activities, kidnapping, insurgency, this may likely affect the effective implementation of school curriculum. Similarly, Magulod (2017) recognized some contributory factors that may define a good relationship between school location and effective implementation. Further, buttressing his view, he opined that in an effective educational center, there is an atmosphere of order, the location of a school dictates, to a reasonable extent, the educational opportunities offered to its recipients. Numerous scholars have provided definitions for the term "School Location." According to Ntibi and Edoho (2017), school location refers to a particular place with regards to its physical surroundings, whether "urban or rural," where an education center is situated. the distribution of social amenities such as electricity, pipe-borne water, and health facilities that favor urban areas over rural areas have an impact on teachers' implementation of curriculum and pupils' performance (Eugene and Ezeh, 2016).

The research is grounded in Gross's (1971) curriculum implementation theory, which posits that the success of any educational program implementation relies on three key elements: teacher ability, management of support facilities, and the clarity of the implementer. According to this theory, effective implementation requires a balanced consideration of school-related factors, teacher-related



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factors, and management or head teacher-related factors. School-related factors encompass the presence of teachers, educational policies regarding the program, availability of resources, networking, and in-service training for teachers. The provision of available resources. Gross emphasizes the direct relationship between school-related factors, teacher-related factors, and head teacher-related factors in achieving successful curriculum implementation. In the context of this study, the theory guides the investigation into, the management of resources and emphasizes the crucial role of resources in ensuring effective implementation. Omollo, Odongo, Raburu (2016) assert that the availability of resources is key to making the implementation of the curriculum tangible and effective. Resources encompass various elements, including infrastructures that shape the school and classroom environment where the curriculum is implemented, stationery such as writing and reading materials, and learning and teaching aids. Instructional materials play a vital role in providing a clear picture of what is to be implemented and how to implement it. The provision and adherence to teaching resources are critical in ensuring the effective implementation of the 9-year Basic Education Curriculum (BEC). Primary school teachers must ensure the availability of adequate and relevant resources to build confidence in implementing the curriculum. This includes having access to the approved nine-year Basic Education Curriculum, teacher's guides, recommended textbooks, writing materials, libraries, and laboratories to support teachers in implementing the curriculum.

Several studies have explored the impact of school location on various educational factors. Ovat, Nwogwugwu, and Idika (2021) conducted a study assessing school location, class size, and academic performance of upper basic students in Cross River State, Nigeria and find out that Urban students performed significantly better than their rural counterparts in core subjects. The study recommended smaller class sizes for rural students and the provision of conducive learning environments for all upper basic students, irrespective of the school location. Darma (2017) investigated the influence of school location and teacher effectiveness on academic achievement among secondary school students in Kano State. The study revealed that teachers in rural areas were less willing to accept responsibilities, and recommendations included the provision of social amenities and effective teachers to enhance students' academic achievement. Also, Iwanie (2018) explored the effects of parental education level and school location on language learning motivation in Poland. The study emphasized the need to raise teachers' awareness of these factors and called for more research involving participants from lower socioeconomic backgrounds. Essien's (2017) study aimed to examine the influence of school location on students' academic achievement in Social Studies in Colleges of Education in Cross River State, Nigeria. The study found no significant effect of school location on academic achievement, the researcher recommended that the government and relevant stakeholders should address the infrastructure gap between rural and urban areas.

Akinkuade (2022) conducted a study on "school location as a determinant of teachers' job performance in private and public secondary schools within Ibadan Metropolis, Oyo State, Nigeria." The findings indicated that school location did not have a significant relationship with teachers' job performance in Ibadan Metropolis, Oyo State, Nigeria. As a result, the study recommended that both government and private school proprietors should ensure that school sites are favorably located. Similarly, Githaka, Gachahi and Mwaruvie (2019) conducted a study in Kenya aimed at examining the impact of social amenities on academic performance in primary schools in Gichugu Constituency, Kenya. The objectives of this study were to assess the status of social amenities, to establish how sanitation amenities influence pupils' performance and lastly, to evaluate challenges facing provision of social amenities in primary schools in Gichugu Constituency, Kenya. This study was guided by



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Social Constructionist Theory. The study adopted the descriptive survey research design. The target population consisted of 75 primary school head teachers. Kathuri and Pal's Table for Sample Size Determination was used to arrive at a sample size of 63 school head teachers who were randomly selected from the target population. A questionnaire and an observation guide were used to collect data from the respondents. Data was analyzed using descriptive statistics with the aid of Statistical Package for Social Sciences (SPSS Version 20). The study established that in majority of the primary schools, pupils had access to clean and safe drinking water though pupils in some schools used water from nearby rivers and stream. The study also found out that majority of the schools had adequate sanitation amenities. However, the study established that sanitation facilities did not cater for learners with physical disabilities. The study established that social amenities influenced learners' academic performance in primary schools. Further, the study established that financial challenges affected provision and maintenance of social amenities in primary schools in the study region. The study recommended that the Ministry of Education and other education stakeholders should facilitate the provision and maintenance of social amenities in primary schools in Kenya in order to improve pupils' academic performance. These studies are pertinent to current research as it investigates the correlation between school location and academic performance within a secondary and primary school context. Academic achievement, which serves as the culmination of effective curriculum implementation, is a key focus. Therefore, the focus of the study is to examine the relationship between availability of social amenities in school location and effective implementation of 9-year BEC in North-west, Nigeria.

Statement of the Problem

Basic schools in North-west, Nigeria where teachers implement curriculum needs to be conducive. Unfortunately, the researcher observed that, some schools are sometimes located without adequate provision of social amenities such as hospital, clinic or dispensary; mobile network; Point of Sale (POS) services among others. Unfavorable school locations may interfere with effective teaching and learning activities, pose challenges to teachers' implementation, and infringe on teachers' well-being and personal comfort. The unfavorable location of schools may significantly undermine the effective implementation of the basic education curriculum, making it difficult to achieve the objectives of basic education. Researchers have explored the impact of school location on teachers' performance, but there is a lack of specificity regarding the availability of social amenities in location of schools, whether in rural or urban areas. These problems, along with related issues, should be a cause for concern. Additionally, there is a lack of studies on the effective implementation of the entire 9-year basic education curriculum (Primary) concerning availability of basic social amenities in school location in the North-Western states. The focus of the study is to investigate the availability of social amenities in school locations as correlate to effective implementation of the 9-year Basic Education Curriculum BEC (Primary).

Objectives of the Study

The general objective of this study was to examine the relationship between availability of social amenities in school locations and the effective implementation of the 9-year Basic Education Curriculum in North-west, Nigeria. The specific objectives of the study were to find out:

1. The level of availability of social amenities in school locations and the effective implementation of the 9-year Basic Education Curriculum in North-West, Nigeria.
2. The relationship between the availability of social amenities in school locations and the effective implementation of the 9-year Basic Education Curriculum in North-West, Nigeria.



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Research Questions

In line with the above objectives, the following research questions were outlined to guide the study:

1. What is the level of the availability of social amenities in school locations and the effective implementation of the 9-year Basic Education Curriculum in North-West, Nigeria?
2. What is the relationship between the availability of social amenities in school locations and the effective implementation of the 9-year Basic Education Curriculum in North-West, Nigeria?

Research Hypothesis

Ho: There is no significant relationship between the availability of social amenities in school location and the effective implementation of Basic Education Curriculum in North-West, Nigeria.

Methodology

The study was conducted using a correlational design. The correlational study envisaged collecting and analyzing data from respondents considered representatives of the entire group in order to measure the degree or extent of relationship between two or more variables for making predictions about the relationship. The population of the study comprised all teachers in public primary schools in the seven North-west states namely: Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto, and Zamfara. There is a total of 16,463 public primary schools and 159,220 teachers, as reported in the 2020/2021 UBEC National Audit. The focus on public primary schools is grounded in the expectation that they adhere to uniform basic education curriculum standards. The target population is narrowed down to include only Kebbi, Sokoto, and Zamfara states. Refer to Table 1 for the distribution of the target population of the study.

Table 1 Distribution of Teachers and Public Primary Schools of the Target Population

S/No	State	School	Teachers
1	Kebbi	261	2441
2	Sokoto	319	4955
3	Zamfara	607	3848,
	Total	1187	9728

Source: State Universal Basic Education Board, Kebbi, Sokoto and Zamfara States, 2023

Multi- stage sampling techniques was used for this study. Simple random sampling technique was used to select three states out of the seven states in the North-west region, namely, Kebbi, Sokoto, and Zamfara. Three education zones, ten LGEA's, fifty Public Primary School and 370 teachers were chosen using research advisors 2006 to represent each of the three states.

Table 2 Distribution of Teachers and Public Primary Schools of the Target Population

States	Education Zones	LGEA	School	Teachers
Kebbi State	Birnin Kebbi Zone	Birnin Kebbi	113	1096
		Gwandu	87	621
		Kalgo	61	724
		Total	261	2441
Sokoto State	Wamakko Zone	Dange Shuni	89	764
		Sokoto South	138	1389
		Wamakko	92	1286
		Total	319	3439
Zamfara State	Gusau Zone	Bungudu	165	1068
		Gusau	159	1368
		Maru	137	644
		Tsafe	148	766
		Total	607	3848



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Total	10	1187	9728
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Source: State Universal Basic Education Boards of Kebbi, Sokoto and Zamfara States, 2023

Table 3 Samples and Sample Size

S/No.	LGEA	No. Schools	Sample Schools	No. Teachers	Sample of Teachers
1	Birnin Kebbi	113	5	1096	41
2	Gwandu	87	5	621	24
3	Kalgo	61	5	724	28
4	Dange Shuni	89	5	764	29
5	Sokoto/South	138	5	1389	53
6	Wamakko	92	5	1286	49
7	Bungudu	165	5	1068	41
8	Gusau	159	5	1368	52
9	Maru	137	5	644	24
10	Tsafe	146	5	766	29
Total	10	1362	50	9728	370

Source: State Universal Basic Education Board, Kebbi, Sokoto and Zamfara States, 2023

Table 3 illustrates the distribution of the respondents proportionate to the number of teachers for the ten local government areas in the three states under study. Two sets of researcher-made instruments were utilized to obtain valid and reliable information on the relationship between school location, and effective implementation of the Basic Education Curriculum. Availability of Social Amenities in School Location Rating Scale (ASASLRS) and Basic Education Curriculum Implementation Questionnaire (BECIQ). The instrument constructed by the researcher employed a 5-point rating scale as follows: 5 points for Very Highly Satisfactory (VHS), 4 points for Highly Satisfactory (HS), 3 points for Moderately Satisfactory (MS), 2 points for Unsatisfactory (U), and 1 point for Very Unsatisfactory (VU). It consists of 6 items, to collect data on the availability of social amenities in school locations while the second instrument utilized for data collection is the Basic Education Curriculum Implementation Questionnaire (BECIQ). This researcher-designed tool aims to gather data on the degree of adherence to the Basic Education Curriculum. It employs a four-point Likert scale, with responses ranging from strongly agree (4 points) to strongly disagree (1 point). The questionnaire comprises 14 items: Items 1-10 assess the extent of implementing the Basic Education Curriculum and Items 11-14 gather information on availability of basic social amenities in school location and its influence on the implementation of the Basic Education Curriculum.

The questionnaires underwent face and content validation by experts in the field of Curriculum Studies, Research Methods, and Statistics within the Faculty of Education and Extension Services at Usmanu Danfodiyo University, Sokoto. The validation comments provided by the experts were then utilized to restructure the items of the instruments. The internal consistency of the two instruments School Location Rating Scale (ASASLRS) and Basic Education Curriculum Implementation Questionnaire (BECIQ) was assessed using split-half, which was further subjected to the Cronbach Alpha reliability coefficient. The reliability coefficient of Availability of Social Amenities in School Location Rating Scale (ASASLRS) was found to be 0.93 and 0.80 for Basic Education Curriculum Implementation Questionnaire (BECIQ). These values are significantly high, justifying the use of the two research instruments.



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The researcher administered the instruments with the assistance of Basic Education Zonal officers, Local Government Education Secretaries of the Local Governments under study, and all the headmasters of the schools under study who served as research assistants. An introduction letter was presented to the relevant authorities responsible for Basic Education to secure permission and formally introduce the researcher and the purpose of the study. Copies of the questionnaire were administered and collected through direct delivery and recovery methods to enhance a high return rate. Data generated for the study were analyzed using the Statistical Package for Social Sciences (SPSS) version 20. Mean and standard deviation was used to respond to the research question and inferential statistics, specifically the Pearson Product Moment Correlation coefficient (PPMC or Pearson r), were utilized in analyzing the null hypothesis.

Presentation of Result

Research Question: what is the level of availability of social amenities in school location and effective implementation of 9-year Basic Education Curriculum in North-West, Nigeria?

Table 4 Availability of Social Amenities in the School Location in North-west Nigeria

S/N	Availability of Social Amenities in School location	N	Mean	SD	Decision
1	School location has a Hospital, clinic or dispensary	370	2.96	1.57	Not Available
2	School location has a provisions store	370	3.02	1.43	Available
3	School location has POS Services	370	3.37	1.40	Available
4	School location has mobile network/services	370	3.61	1.47	Available
5	School location has a motor park	370	2,52	1.27	Not Available
6	School location has business centers	370	3.36	1.38	Not Available
	Average	370	3.14	1.42	Available

Source: field work, 2024

Table 4 provides a summary of mean and standard deviation calculations used to assess the extent of the availability of social amenities in school locations for the implementation of the Basic Education Curriculum (BEC) in North-West Nigeria. The analysis revealed an overall average mean of 3.14 with a standard deviation of 1.42, which surpasses the criterion mean of 3.00. This indicates that primary school teachers in the study perceive that social amenities are available in the school locations where the BEC is being implemented among primary schools in North-West Nigeria.

Hypothesis Testing

The hypothesis was tested at the 0.05 level of significance and are presented as follows:

Null Hypothesis (H0): There is no significant relationship between the availability of social amenities in the school location and the effective implementation of the 9-year Basic Education Curriculum in North-West, Nigeria.

Table 5 Pearson Correlation Coefficient between Social Amenities in School Location and Effective Implementation of BEC among Primary School Teachers in North-West, Nigeria.

Variables	N	Mean	SD	Df	r-Cal	P	Decision
Availability of Social Amenities	370	20.3	6.75	368	0,157**	0.002	H0₂ Rejected
Effective Implementation	370	126.0	35.4				

** Correlation is significant at 0.01 levels (2-tailed)

Table 5 is a summary of Pearson's Product Moment Correlation Coefficient, conducted to determine the significance of the degree of linear relationship between the availability of social amenities in school location and the effective implementation of the Basic Education Curriculum (BEC) among primary schools in North-West Nigeria. The analysis revealed that there was a statistically significant



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positive correlation between the availability of social amenities in school location and the effective implementation of BEC among primary schools in North-West Nigeria. It was concluded that the higher the level of availability of social amenities in the school location, the higher and more effective the implementation of the Basic Education Curriculum (BEC) among primary schools in North-west Nigeria.

Summary of Finding

The study found a statistically significant positive correlation between the level of social amenities in the school location and the effective implementation of the Basic Education Curriculum (BEC) in North-west Nigeria. This suggests that teachers in schools located with available social amenities were effective in implementing the Basic Education Curriculum in North-west Nigeria.

Discussion of Finding

The study found a statistically significant positive correlation between the level of social amenities in school location and the effective implementation of Basic Education Curriculum (BEC) in North-west Nigeria. This indicates that teachers in schools located where social amenities are available were more effective in implementing the Basic Education Curriculum than those in schools with fewer available social amenities in North-west Nigeria. Contributing to the significance of social amenities in school location to the effective implementation of basic education, Njiru; 2014, Eugene; and Ezeh; 2016, Akinsanya; 2016, Ntibi and Edoho; 2017, Arop and Owan; 2018, also Akinkuade; 2022, all emphasizing the importance of social amenities such as electricity, pipe-borne water, and health facilities for effective implementation, particularly favoring urban areas over rural areas. They highlight that the dispersion of educational facilities, opportunities, and tutors can impact the educational landscape in Nigeria. The availability of social amenities in a school's location is crucial, and the chosen site should ideally include facilities such as health care services, commercial services, police stations, banking services, markets, firefighting services, and postal and telecommunication services. Health care services, including hospitals, dispensaries, clinics, or pharmacies, are essential for providing health care to pupils and staff, especially during emergencies. Contributing to the need of available social amenities in primary Githaka, Gachahi and Mwaruvie 2019; Social amenities in primary schools play an important role in the provision of quality education and established that social amenities influenced learners' academic performance in primary schools.

Conclusion

Based on the findings of this study, it is concluded that the discrepancy between the objectives of Basic Education and the implementation disposition of teachers could be attributed to lack of availability of basic social amenities. It is not surprising, therefore, to observe that many teachers struggle to implement the approved curriculum package in compliance with the limited access to basic social amenities. The implementation efforts as a result, the goals of achieving diverse basic knowledge and skills for entrepreneurship, problem-solving skills, value reorientation, and simple safety skills that would enable children to function effectively in society and realize their full potentials may not be tenable or achievable. Consequently, the challenges in providing quality basic education that Nigeria faces will persist for a long time to come.

Recommendation

Based on the finding of this study, it was recommended that; Governments, schools, and community members should collaborate to provide social amenities, facilitating the discharge of duties by teachers and achievement of the objectives of primary education by pupils.



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Assessment of Manpower-Development-and-Training on ... Umoru R. S., Et. al. (2025)

Assessment Of Manpower-Development- And-Training on Service Delivery among United Bank for Africa (UBA) Staff in Otukpo Local Government Area of Benue State, Nigeria

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Abstract

This study assesses the impact of manpower development and training on service delivery among United Bank for Africa (UBA) staff in Otukpo, Nigeria. In the dynamic and competitive banking sector, human capital is a critical driver of organizational success. Effective manpower development and training programs are essential to enhance employee skills, improve performance, and ensure high-quality service delivery. This research investigates the current state of training initiatives at UBA Otukpo, identifies gaps in employee development, and examines the relationship between training and service delivery outcomes. Using a mixed-methods approach, data will be collected through surveys, interviews, and performance metrics to evaluate the effectiveness of existing programs. The findings aim to provide actionable insights for UBA management to optimize training strategies, boost employee productivity, and strengthen customer satisfaction, ultimately contributing to the bank's operational excellence.

Keywords: Assessment, Manpower, Development

Introduction

In a developing country like Nigeria, training and development of manpower resources is highly needed in virtually all business organizations for its effectiveness. It is hard for any business organization to exist without adequate manpower hence it is an indispensable tool for any business organization. Manpower training and development is one of the most important organizational dynamics. It constitutes the pivot in which organizational survival is run. The training process is one of the most pervasive methods for enhancing the productivity of individuals and communicating organizational goals to personnel (Ekaterini, 2019).

Manpower is the basis of all resources and it is the indispensable means of converting other resources to mankind's use and benefits. So how well we develop and employ human resources skills is fundamental in deciding how much we will accomplish as a nation. Manpower is the pivot of every human institution. Even in the developed and industrial nations of the world where the use of machines and technology is at an advanced stage, manpower is still very essential (Comma, 2018). Training therefore holds the key to unlock the potential growth and development opportunities to



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achieve a competitive edge. In this context, organizations train and develop their employees to the fullest advantage in order to enhance their effectiveness (Devi & Shaik, 2015). For employees to perform their functions effectively there must be well designed training and development programs to enable them enhance their productivity. Manpower, according to Omodia (2019) is the most active and indispensable factor in the process of production in organization and so should be given its rightful place as an option for organization performance. It is the most important of resources in all organizations and among the four factors of production (Emejulu, 2012). It consists of employees/workers in organizations who accomplish the goals of the organization.

Objectives of The Study

The broad objective of the study is to assess the impact of manpower training and development on organizational effectiveness in Nigeria. The specific objectives of the study are to:

- i. determine the method of manpower training and development in United Bank for Africa (UBA).
- ii. Highlight the benefits of training and development in United Bank for Africa (UBA).
- iii. Ascertain the impact of training/development on United Bank for Africa (UBA).

Research Questions

RQ1. What are methods of manpower training and development in United Bank for Africa (UBA)?

RQ2. What are the objectives of manpower training and development in United Bank for Africa (UBA)

RQ3. What are the effects of manpower training and development on United Bank for Africa (UBA) performance?

Methodology

The research methodology approach is the specification of methods and procedures for acquiring the relevant information needed for the subject of the study. It is the overall operational pattern of framework of this project stipulating what information to be collected from which source and by what procedures, taking proper and careful consideration of the objectives.

Research Design

The research adopted a survey research design. The purpose was to allow the researchers to fully describe and explain conditions of the present by using many subjects and questionnaires to fully describe a phenomenon.

Population of The Study

The population of study is made up of 20 staffs of United Bank for Africa (UBA) Otukpo Branch.

Sample and Sampling Techniques

A sample and sampling techniques was 15. The sample size was calculated using Guilford and Flruchter formula for estimating sample size (Oladipo and Abdulkadir, 2010):

Method Of Data Collection

The sources of data were both primary and secondary. The primary data were collected through questionnaire administration supported by face-to-face while secondary data were obtained from journals, textbooks and internet. The questionnaire was designed in a 5-point Likert scale format. Sixty six (66) copies of the questionnaire were administered. 58 were duly completed and returned while 8 were found bad.

Method of Data Analysis

The data generated from the field were presented and analyzed with descriptive statistic while the corresponding hypotheses were tested with the chi-square, Pearson's Correlation and linear regression at 0.05 alpha level with the aid of computer through the application of Statistical Package



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for Social Science. Five Likert point scale response categories were distributed for research questions 1, 2 and 3 by the researchers as represented in Table 1 below:

Table 1: Mean Rating

Response Categories	Point	Boundary Unit
Strongly Agree (SA)	5	4.50 – 5.00
Agree (A)	4	3.50 – 4.49
Undecided (UD)	3	2.50 – 3.49
Disagree (D)	2	1.50 – 2.49
Strongly Disagree (SD)	1	1.00 – 1.49

The mean rating that falls above 3.50 are regarded as agreed, the mean rating that falls below 2.49 are regarded as undecided. Data were analyzed using descriptive and inferential statistics. Pearson moment correlation was used to test the relationship among the variables. And analysis of variance (ANOVA) was used to test the hypothesis.

Presentation of Data and Analysis

Data collected from the respondents were presented and analyzed using frequency counts, descriptive statistics and Pearson moment correlation. Also, the empirical results of the hypothesized relationships among the variables are reported. Various relationships were statistically tested through structural equation modelling, multiple regression and analysis of variance (ANOVA). These results were interpreted in terms of research objectives.

Data Presentation

The result of the data analyses are presented below.

Q1. What are methods of manpower training and development in United Bank for Africa (UBA)?

Table 1: Methods of Manpower Training and Development in Organization

Items	Mean	Decision
Coaching	4.50	Strongly Agree
Orientation/induction	4.44	Strongly Agree
Apprenticeship	4.96	Strongly Agree
Demonstration	4.90	Strongly Agree
Classroom training	3.65	Agree
Counselling	3.65	Agree
Job instruction	4.70	Strongly Agree
Delegation	3.55	Agree
Learning from Colleagues	2.45	Undecided
Special projects and special courses	3.60	Agree
Group discussion	3.96	Agreed
Conference	4.00	Strongly Agree
Lectures	3.98	Agreed
Job rotation	4.91	Strongly Agree
Professional body membership	3.65	Agreed

Source: Field Survey, 2025.

Table.1 presents the methods of manpower training and development in organization. Looking at the mean scores which do not vary much, it shows that pattern of response were quite similar with one another. However, the analysis indicated that apprenticeship method of training and development of staff has the highest mean score of 4.96 compared to all other methods. This means that all the respondents agreed that their organizations adopt the apprenticeship method of training and development of their staff. Analysis of the table 1 further shows that job rotation method of training and development recorded a mean score of 4.91, and demonstration method of training and



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development recorded a mean score of 4.00 respectively. This result indicated that majority of the respondents agreed that their organizations are committed to training and development.

Q2. What are the objectives of manpower training and development in United Bank for Africa (UBA)

Table .2: The Objective of Manpower Training and Development in Organisation.

Items	Mean	Decision
To improve the quality and quantity of workers' production	4.57	Strongly Agree
To help increase the performance of workers efficiently and effectively	4.60	Strongly Agree
To help increase workers' morale and enthusiasm for work	3.69	Agree
Help increase workers' job satisfaction and motivation.	3.60	Agree
To reduce chances of industrial accident and help workers be adaptable to ever changing realities of modern business world and technology	4.61	Strongly Agree
To help modify the behaviour and attitude of workers towards their job and organization	4.47	Strongly Agree
To help equip the workers with skills and techniques that will enable then challenge their competitors	4.77	Strongly Agree

Source: Field Survey, 2025.

Table 2 presents the objectives of manpower training and development in organization. Looking at the mean scores which do not vary much, it shows that pattern of response were quite similar with one another. However, the analysis indicated that the objective of helping to equip the workers with skills and techniques that will enable then challenge their competitors has the highest mean score of 4.77 compared to all other objectives. The analysis of the table 4.2 further shows that manpower objective of reducing the chances of industrial accident and help workers be adaptable to ever changing realities of modern recorded a mean score of 4.61, and helping to increase the performance of workers efficiently and effectively of training and development recorded a mean score of 4.60 respectively.

Q3. What are the effects of manpower training and development on United Bank for Africa (UBA) performance?

Table 3: Effect of Manpower Training and Development in achieving Organizational Performance.

Items	Mean	Decision
Increase in production of goods and services.	4.71	Strongly Agree
Increase in effectiveness and Efficiency of workers.	4.55	Strongly Agree
Preparation of workers for higher Responsibilities/jobs	4.59	Strongly Agree
Boasts workers morale and Increase job satisfaction	3.59	Agree
Increase capacity to adopt new Technology and methods.	3.61	Agree
Reduces employee turnover and Enhanced company's image	3.96	Agree



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Reduces waste, accident, lateness And absenteeism of workers	3.78	Agree
Increases workers skill, knowledge And techniques of handling a job	4.55	Strongly Agreed

Source: Field Survey, 2025.

Table 3 presents the objectives of manpower training and development in organization. Looking at the mean scores which do not vary much, it shows that pattern of response were quite similar with one another. However, the analysis indicated that the increase in production of goods and services has the highest mean score of 4.71 compared to all other objectives. The analysis of the table 3 further shows that preparation of workers for higher responsibilities/jobs recorded a mean score of 4.59, while increase in effectiveness and efficiency of workers and increases workers skill, knowledge and techniques of handling a job recorded a mean score of 4.55 respectively.

Hypotheses Testing

The test was conducted using multiple regression analysis. This test established whether inter-personal relation and team work are the effects of training and development on organizational Performance.

Table 4: Model Summary

Model	R	RSquare	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	Df1	Df2	Sig. F Change
1	.626 ^a	.391	.383	.96049	.391	46.939	5	365	.000

a. Predictors: (Constant), increase in production of goods and services, increase in effectiveness and efficiency of workers, preparation of workers for higher responsibilities/jobs, boasts workers morale and increase job satisfaction, increase capacity to adopt new technology and increases workers skill, knowledge and techniques of handling a job.

Source: Author's Computation, 2025.

The model summary shows that increase in production of goods and services, increase in effectiveness and efficiency of workers, preparation of workers for higher responsibilities/jobs, boasts workers morale and increase job satisfaction, increase capacity to adopt new technology and increases workers skill, knowledge and techniques of handling a job of staff account for 39.1% of the variation of the organizational performance (i.e coefficient of determination).

Discussion of Findings

The result of the study revealed that manpower training and development in United Bank for Africa (UBA) can be done through coaching of workers, orientation and counseling of the workers. This is in line with the view of Ogunbameru (2004). They suggested that methods of training and development of workers include on-the-job-training and off-the-job training such as; apprenticeship, demonstration, orientation, coaching and so on. It further revealed that job instruction, delegation, special projects, group discussion, programmed instructions were also among the methods of training and development manpower in organizations for effective organizational performance. This corroborated the assertion of Ewuim and Ubochi (2007) that simulation conferences, case study, role playing, lecturing, job rotation and so on, were among the methods of training and development of manpower in organizations. This is because these methods are tested and found reliable for increased productivity and self-reliance if practiced fully by the organization. However, the finding revealed that learning from colleagues may or may not be effective methods of manpower training



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and development. This might be as a result of non-specification/clarification of type or level of colleagues whether ordinary friends or experts in the field.

Result in table 2 revealed that the objectives of manpower training and development are to improve the quality and quantity of workers' productivity and to help increase the performance of the organization. Draft (1983) agreed with this result when he suggested that increased productivity is among the major objective of manpower training and development. This study also revealed that organization involved training and developing manpower because of the major objective of increased workers morale and enthusiasm which would assist heavily in increasing organizational productivity. Among other objectives of manpower training and development are to reduce industrial accident, modify behaviour of workers towards job, equip workers with skills and techniques that will enable them challenge their competition etc. Ogunbameru (2004) summarizes that executive development programme aimed at improving the managers' decision-making skills, interpersonal skills, organizational knowledge, general knowledge specific individual's needs, job knowledge etc. could improve staff morale.

Table 3 results indicated that training and development of manpower, in organization affects organizational performance in the area of increase in productivity and effectiveness and efficiency of workers. This also concurs with Cole (2007) who suggested that training need arises from demand of the job and demand of the organization. Thus, the effect of manpower training and development is for increased production and increase in effectiveness of workers. The study further revealed that manpower training and development prepare workers for higher job/responsibilities, boosts workers morale and increases job satisfaction in the organization. The description of wikipedia (2010) synchronizes with this result. Johnson and Scholes (2002) summarized that increased job satisfaction and morale among employees were among the effects of manpower training and development. This is because during training the worker is meant to understand his job and the importance of his job schedule to the organization. Other effects of manpower training and development as revealed by the study include; increased capacity to adopt new technologies and methods, reduction in employee turnover, which is in agreement with the views of Kayode (2001).

Finally, manpower training and development as indicated by the result of the study assist immensely in increasing workers' skills, knowledge and technologies of handing a job in an organization. As a result of this, the use of modern technology in production was found very easy. Workers on their own were able to do things by themselves based on their practical experiences during training and development. Training forms the core of apprenticeships and provides the backbone of content at institution of technology (Cole 2007 and Wikipedia, 2010). It is a learning activity which is directed to the acquisition of specific knowledge and skill for the purpose of an occupation or task. (Ivancevich et-al, (1994).

Conclusion

Training and retraining are essential components of manpower development. Training and personnel development is a mixture of activities aimed at improving the performance of personnel in organizations for the attainment of continuous improvement in productivity. Training and human development assists employees to learn how to use the resources in an approve way that allows organization to meet its desired output. It is an undisputed fact that effective training is an investment in the human resources of an organization, with both immediate and long –range returns. However mere investment is not enough; organizations need to manage training programs more



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effectively so that they can get the highest returns from their investment. The ultimate aim of every training and development program is to add value to human resource. Any training and development program that would not add value should be abandoned. The issue of manpower training and development is treated with levity and neglect and there is this misconception of the aim of manpower training, because it is been seen as a tool or means for staff promotion rather than seeing it from an holistic angle as a tool for staff development, maintenance for greater performance and retention.

From the study it is evident that organizational performance depends largely on manpower training and development. Manpower training and development is a programme designed purposely for the staff in an organization, to enable them work towards taking the organization to its expected destination. These destinations are the goals which an organization set for themselves. To actualize these goals, proper methods of training and development of manpower is required through on-the-job training methods such as: job institution, coaching, demonstration conferences etc.

Recommendations

In view of the findings of this research work of the role of manpower training and development in achieving organizational goals, the study proffered the following recommendations.

1. Banking organizations should set up regular training and development programmes that are capable of raising the skills, morale and productivity of employees. It is strongly suggested that personnel managers of banking organizations should involve experts in mapping out their training and development needs. The reason for this is to avoid wastes, both in terms of time and resources, by providing what is actually needed and very relevant to the needs of the employees. When this is done, the objectives of manpower training and development will be realized, thus repositioning the organization at the level of higher performance.
2. Organizations should view training broadly as a way to create intellectual capital. Intellectual capital includes basic skills (skills needed to perform one's job), advanced skills (such as how to use technology to share information with other employees).
3. The United Bank for Africa, as one of the organization, should embark on a strategy using dependable and independable variables. The dependable variables impacting training and development on staff while independable variables are performance of staff.

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Rethinking Learner Autonomy: The Role of ... Omoyajowo, B. S. Et. al.. (2025)

RETHINKING LEARNER AUTONOMY: THE ROLE OF ARTIFICIAL INTELLIGENCE IN ENHANCING SELF-REGULATED LEARNING IN NIGERIAN HIGHER EDUCATION

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Abstract

The integration of Artificial Intelligence (AI) in education is transforming global teaching and learning practices; however, its application in enhancing self-regulated learning (SRL) and learner autonomy within Nigerian higher education remains under-theorized. This study adopts a theoretical approach to examine how AI technologies—such as intelligent tutors, chatbots, and learning analytics dashboards—can support the core dimensions of SRL: planning, monitoring, and reflection. Drawing on Zimmerman’s Self-Regulated Learning Theory and Bandura’s Social Cognitive Theory, the paper explores how AI tools promote metacognitive awareness, goal setting, and feedback-driven reflection, thus enabling learners to become more autonomous and strategic in managing their learning. The study also critically examines the contextual challenges hindering effective AI adoption, including infrastructural deficits, limited educator readiness, and ethical concerns around transparency and data privacy. A conceptual framework is proposed to illustrate the pathways through which AI tools can enhance learner agency, moderated by socio-technical and institutional factors. The paper concludes with recommendations for curriculum innovation, policy reform, and professional development to support ethical, inclusive, and learner-centered AI integration in Nigerian higher education.

Keywords: Learner autonomy, Artificial Intelligence, Self-regulated learning, Higher education.

Introduction

Global education is rapidly evolving, and new technology and student autonomy are becoming increasingly significant. AI is one of the most potent forces in this evolving society. It changes how knowledge is shared, accessed, and personalised. Intelligent tutoring systems, learning analytics,



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generative AI models (ChatGPT), and adaptive learning platforms are changing the teacher-centred paradigm to be more learner-centred. AI offers a powerful opportunity to rethink educational practices, particularly in the cultivation of learner autonomy, in Nigerian higher education, where overcrowded classrooms, inadequate instructional materials, and limited access to personalised support persist. An emerging field, artificial intelligence in education (AIED) affects curriculum design, evaluation, and learner assistance (Chiu et al., 2021). AI's ability to handle vast amounts of data, detect learner behaviour patterns, and deliver fast feedback makes it a tempting tool for educational fairness and personalisation. Hwang et al. (2020) state that AI's educational functions include intelligent content development, adaptive instruction, automated assessment, and dynamic learner modelling. Recently, apps like ChatGPT have showed promise as learning companions, explaining, summarising, and encouraging deeper thought (Sullivan et al., 2023). AI has great promise, but it must be implemented carefully, especially in locations with different infrastructure and pedagogical preparedness.

Educational research has also focused on self-regulated learning (SRL) as a key capacity for academic performance and lifetime learning. SRL requires learners to plan, monitor, and evaluate their learning (Lee et al., 2018). Setting objectives, managing time, using tactics, requesting support, and reflecting on results are examples. When knowledge is abundant and instructors are shifting from information providers to facilitators, learners must be able to govern their own learning. Self-regulation abilities are crucial to academic success and retention in higher education, especially online and hybrid learning (Zhang et al., 2022; Karlen, 2023). Fostering SRL is difficult, especially in schools with rote learning, teacher-dependence, and inadequate metacognitive instruction. Higher education in Nigeria is no exception. Traditional lectures impede student freedom, metacognition, and strategic learning. Given these limits, AI can improve SRL by providing timely feedback, fostering reflective thinking, scaffolding goal-setting, and replicating tutor-learner interaction (Chiu, 2023). AI tools may assess students' study patterns and recommend personalised improvement techniques, helping them manage their academic development. According to Gui (2021), 5G and AI can digitise and democratise education, empowering students from all socioeconomic levels. AI can help students in Nigeria access personalised learning resources regardless of location or institution, reducing digital inequalities. Despite its promise, AI in education raises ethical, data privacy, algorithmic bias, and academic integrity concerns (Sullivan et al., 2023). Higher education relies on authentic learning and assessment for academic legitimacy, making these concerns crucial. Thus, stakeholders must balance AI's capabilities with education's essential principles.

This study investigates how AI can increase learner agency and autonomy in a situation with potential and challenges. The paper examines how AI apps are being used (or could be used) to facilitate SRL among Nigerian university students, identifies enablers and hurdles, and provides evidence-based suggestions for educators and institutions. This study adds to the growing body of research on the pedagogical, technological, and environmental factors that affect AI use in education. The findings should inform worldwide movements towards digital and learner-centred education policy and instruction. The project also aims to help Nigerian higher education improve academic performance and prepare students for the knowledge economy, which requires self-directed, digitally literate graduates. Furthermore, this study comes at a crucial time in global and local education systems. It recognises that while AI has great potential to improve education, its greatest influence may come from empowering learners to take ownership of their learning journeys. This study



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examines AI and self-regulated learning in Nigerian higher education to assist students become more independent, engaged, and successful in the digital age.

Literature Review

The concepts of learner autonomy and self-regulated learning (SRL) have become increasingly central to contemporary educational discourse, especially in light of recent technological advances and the shift toward more learner-centred pedagogies. These constructs, while related, emphasize distinct but complementary facets of the learning process. Learner autonomy emphasizes the learner's capacity to take control of their learning, while SRL focuses on the strategies and cognitive processes learners use to manage, monitor, and reflect on their learning. Together, they offer a powerful framework for fostering lifelong learning, academic success, and adaptability in diverse educational contexts.

Learner Autonomy: Conceptual Foundations

Learner autonomy is the skill and willingness to take charge of learning. It requires independence from direct instructor control and educated choices about learning goals, resources, tactics, and assessments. Loeng (2020) states that adult education and lifelong learning allow learners to diagnose their learning requirements, set goals, find resources, and evaluate outcomes. Adult learners need self-direction, and younger generations in complex, information-rich situations need it more. With Generation Z at the forefront of education, autonomy is both a pedagogical ideal and a practical requirement. Chardonens (2025) notes that Generation Z learners want personalised, interactive, and tech-mediated learning. They thrive in autonomous contexts with structured metacognitive growth and technology scaffolding. This makes learner autonomy a dynamic interaction between freedom and guided help, especially as education moves towards hybrid and digital models.

Self-Regulated Learning (SRL): Strategies and Significance

Self-regulated learning refers to the degree to which learners are actively involved in their own learning process through goal setting, strategy selection, self-monitoring, and reflection. SRL is a cyclical process that encompasses cognitive, metacognitive, motivational, and behavioural components. Teich et al. (2024) further demonstrate the importance of adaptive support mechanisms in promoting SRL strategies, particularly in continuing education and online courses. Their findings reveal that learners often require explicit prompts and personalized feedback to effectively regulate their learning, even when they have access to quality digital content. Chardonens (2025) also emphasizes the integration of metacognitive strategies into technology-enhanced learning environments. He posits that AI-powered tools can facilitate SRL by offering real-time feedback, suggesting learning strategies, and helping students visualize their learning progress. For example, intelligent tutoring systems can prompt students to reflect on their understanding or adjust their approach to a problem. Such tools act as "scaffolds" that gradually build learners' capacity for autonomous learning.

Applications of Artificial Intelligence in Education

AI is being used in education to improve teaching, streamline administration, and personalize learning. AI offers revolutionary prospects across multiple academic levels as educational institutions worldwide aim to increase efficiency and learner outcomes. Ge and Hu (2020) note that AI has revolutionized higher education management with intelligent scheduling, automated evaluation, and predictive analytics. These apps optimize resource allocation, decrease administrative burdens, and enable data-driven decision-making. AI has helped administrative management organizations estimate enrolment trends, identify at-risk students, and automate repetitive jobs, increasing



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responsiveness and planning. AI-powered learning tools enable personalized and adaptable instruction. Intelligent teaching systems, speech recognition tools, and automated essay scoring engines are listed by Xu et al. (2021). The tools adjust content to individual learners, track learning behaviours in real time, and provide quick feedback, improving student engagement and learning efficiency. In Nigeria, Ezekiel and Akinyemi (2022) study University of Ibadan teachers' views on AI in education. Their findings show that AI's potential to improve assessment accuracy and student tracking is becoming more widely known. The study also raises technical infrastructure, training, and ethical issues like data privacy and academic integrity. These studies demonstrate AI's many educational uses. From administration to personalized learning, AI could transform institutions and education. However, careful investment in infrastructure, capacity building, and ethical frameworks is necessary to fully realize these benefits, especially in developing countries like Nigeria.

Theoretical Framework

Zimmerman's Self-Regulated Learning Theory

Zimmerman's Self-Regulated Learning (SRL) Theory, proposed by Barry J. Zimmerman in the 1980s, is a comprehensive framework that explains how learners take control of their own learning processes through a cycle of planning, performance, and self-reflection. According to Zimmerman (1986), self-regulated learners are those who actively set goals, select appropriate strategies, monitor their progress, and reflect on the outcomes of their learning. The theory emphasizes that effective learning is not just about acquiring knowledge but also about developing the ability to manage one's cognitive, motivational, and behavioural processes in pursuit of academic success. This theory is highly relevant to the present study, as it provides a foundation for understanding how students in Nigerian higher education can become autonomous learners. In particular, it supports the notion that self-regulated learning is not innate but can be developed and enhanced through targeted interventions. Artificial Intelligence (AI) tools, such as intelligent tutoring systems and learning analytics platforms, can play a crucial role in facilitating the SRL cycle by prompting learners to set goals, track their progress, and receive personalized feedback. As such, Zimmerman's theory serves as a conceptual lens for exploring how AI can enhance learner autonomy and improve educational outcomes in Nigerian universities.

Bandura's Social Cognitive Theory

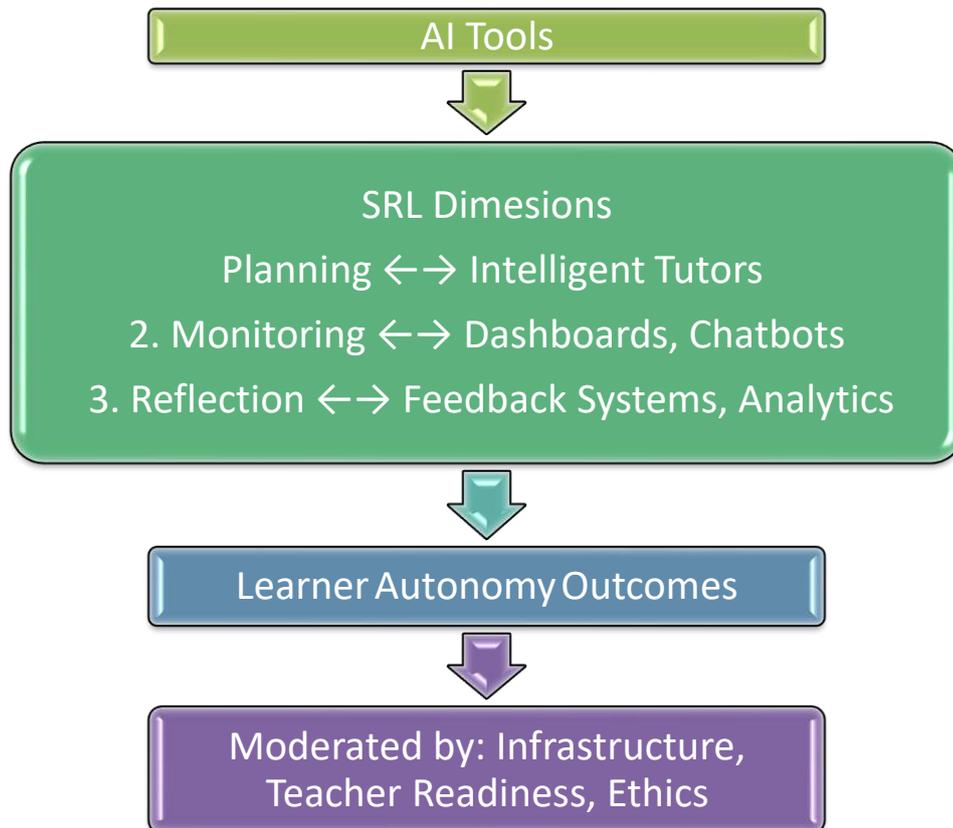
Albert Bandura's Social Cognitive Theory, originally developed in 1986, is a psychological framework that emphasizes the role of observational learning, social interaction, and self-efficacy in human behaviour. Central to the theory is the concept of reciprocal determinism, which suggests that personal factors (like beliefs and attitudes), behavioural patterns, and environmental influences interact to shape individual learning and development. Bandura (1986) argued that individuals learn not only through direct experience but also by observing others and modelling their behaviours. In the context of this study, Bandura's theory provides a social and cognitive foundation for understanding how learners develop the confidence and skills needed to regulate their own learning. AI tools, when designed effectively, can simulate social interactions (e.g., via chatbots or adaptive feedback systems) that reinforce learning through modelling and encouragement. For example, AI-powered virtual tutors can demonstrate problem-solving strategies, provide motivational scaffolding, and adapt content delivery based on learner behaviour, all of which align with Bandura's emphasis on observational learning and environmental support. Moreover, by enhancing students' self-efficacy through timely feedback and personalized learning paths, AI can strengthen their willingness to engage in autonomous and self-regulated learning, especially in resource-constrained environments like Nigerian higher education.

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Conceptual Framework

The conceptual framework for this study is designed to illustrate the interplay between Artificial Intelligence (AI) tools and the core dimensions of Self-Regulated Learning (SRL), such as planning, monitoring, and reflection, within the context of Nigerian higher education. Grounded in Zimmerman’s Self-Regulated Learning Theory and Bandura’s Social Cognitive Theory, this framework explores how specific AI applications (such as intelligent tutors, learning analytics dashboards, and chatbots) can facilitate the development of autonomous learning behaviours by supporting students’ metacognitive and motivational processes. In the Nigerian educational context, where challenges such as limited teacher-student interaction, infrastructural gaps, and uneven access to digital resources persist (Petrie et al., 2020; Nkwenti et al., 2023). AI tools offer a transformative means of enabling students to independently manage their learning. However, the use of AI must be guided by ethical standards (Nguyen et al., 2022; AI Ethics and Higher Education, 2022) and pedagogical purpose (Jin et al., 2023; Hooda et al., 2022). The framework is shown in figure 1 below:

Figure 1: AI-SRL-LR Model



Source: Authors (2025)

Constructs and Relationships in the AI-SRL-LR Model

The conceptual framework is organized around two major constructs:



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1. **AI Tools in Education:** AI applications provide intelligent and adaptive support to learners through:
 - i. **Intelligent Tutoring Systems (ITS):** Deliver personalized instruction and instant feedback (Hooda et al., 2022).
 - ii. **Chatbots and Virtual Assistants:** Offer 24/7 learning support, answer queries, and provide reminders.
 - iii. **Learning Analytics Dashboards:** Help learners track their progress, time management, and resource use (Jin et al., 2023).
2. **SRL Dimensions:** Self-regulated learning consists of three cyclical and interdependent phases:
 - i. **Planning:** Setting learning goals, selecting strategies, and allocating resources.
 - ii. **Monitoring:** Tracking progress, assessing performance, and adjusting strategies.
 - iii. **Reflection:** Evaluating learning outcomes, identifying mistakes, and planning for improvement.

The model proposes that Artificial Intelligence (AI) tools act as external mediators that scaffold learners' self-regulated learning (SRL) processes by supporting them through each phase of the SRL cycle: planning, monitoring, and reflection. These tools are not merely technological add-ons but serve as active facilitators of cognitive and metacognitive development. During the planning phase, intelligent tutoring systems guide students in setting realistic academic goals, identifying learning objectives, and selecting appropriate strategies. By offering personalized recommendations based on learners' performance history and cognitive profiles, these AI tools empower students to initiate learning with clarity and intention. In the monitoring phase, tools such as chatbots and learning analytics dashboards provide real-time feedback on learners' activities, track progress toward goals, and highlight areas of difficulty or improvement. This immediate, data-driven insight encourages students to evaluate their ongoing performance and make strategic adjustments where necessary. During the reflection phase, AI technologies support post-task evaluation through automated feedback, personalized performance summaries, and visual representations of learning trends. These reflective prompts and analytics encourage deeper metacognitive processing, enabling students to assess the effectiveness of their learning strategies and make informed changes for future tasks.

Importantly, social and environmental factors, as emphasized in Bandura's Social Cognitive Theory, moderate the relationship between AI tools and SRL outcomes. The success of AI-enhanced learning depends significantly on the availability of enabling infrastructure such as internet connectivity and digital devices, as well as educator readiness and institutional support systems (Ayanwale et al., 2022; Oyetola et al., 2024). Without these conditions, the potential of AI tools to facilitate autonomy and SRL remains limited. Finally, ethical considerations are foundational to ensuring that AI promotes learner agency rather than dependency or manipulation. As highlighted by Nguyen et al. (2022) and Onyejebu (2023), transparency in AI decision-making, data privacy protections, and fairness in algorithmic outputs are essential for building trust and encouraging meaningful engagement. Responsible AI use in education must therefore align with principles that uphold learner dignity, equity, and empowerment.

Methodology

This study adopted a theoretical research approach to critically explore the intersection between learner autonomy, self-regulated learning (SRL), and the role of Artificial Intelligence (AI) in Nigerian higher education. Unlike empirical research that relies on primary data collection, theoretical research focuses on synthesizing existing knowledge, frameworks, and conceptual models to



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generate new insights or reinterpret existing phenomena (Anfara & Mertz, 2014). In this context, the study aimed to conceptualize how AI technologies can be harnessed to promote SRL and learner autonomy within the unique social, cultural, and infrastructural realities of Nigeria's tertiary education system. The research employed a descriptive theoretical design, which is appropriate for articulating and analysing the components of complex educational issues without direct fieldwork or experimentation (Miksza & Elpus, 2018). Descriptive theoretical designs are commonly used in education and social sciences to analyse relationships among theoretical constructs, clarify definitions, and propose explanatory models. Through this design, the study systematically reviewed relevant literature, examined existing theories, and applied them to the Nigerian higher education context. The study relied primarily on secondary data, drawn from a range of peer-reviewed journal articles, policy documents, theoretical books, and empirical reports. The selected literature included foundational works on self-regulated learning and learner autonomy, as well as contemporary studies on AI integration in education. The research also incorporated policy documents and theoretical texts that addressed educational challenges in Nigeria, particularly those related to digital transformation, pedagogy, and access to learning technologies. A conceptual analysis method was employed to organize and interpret the selected literature. This involved identifying key concepts such as "learner autonomy," "metacognition," "AI-enhanced learning," and "self-regulation," and examining their interrelationships through theoretical mapping. Drawing on the works of Welch and Patton (1992), this analytical process was iterative, allowing for both deductive engagement with existing theoretical constructs and inductive interpretation of their relevance to the Nigerian higher education context.

Discussion of Findings

AI and the Promotion of Metacognition

Learners can monitor, assess, and alter their learning techniques through metacognition. Students rarely obtain metacognitive help in typical Nigerian classrooms, which are lecture-based and provide little formative feedback. However, AI provides revolutionary tools that help this learning element. According to Jin et al. (2023), AI applications like learning analytics dashboards, intelligent tutoring systems, and virtual learning companions are helping students understand their cognitive processes. These technologies show learning progress in real time, suggest strategic changes, and stimulate reflection. AI-powered systems can help Nigerians overcome overworked professors and limited resources by providing continual, individualized feedback that helps students assess their learning.

AI can identify trends in student blunders and promote metacognition like "Do you need to revisit this concept?" or "What strategy worked best for you in solving this type of problem?" (2022, Hooda et al.) These reflecting cues let students take ownership of their learning, a prerequisite for educational autonomy. AI also promotes metacognition by making learning apparent. AI design should be transparent, according to Nguyen et al. (2022), so learners may understand how their data is used and how recommendations are made. Transparency promotes trust and improves metacognitive awareness by helping students interpret feedback and adjust their strategies. AI-driven learning platforms can help passive Nigerian university students become active and self-reflective learners.

AI and Goal Setting

SRL also requires setting SMART goals to guide learning. AI provides structured help through personalised goal recommendations, progress tracking, and adaptive feedback loops. AI systems can help students define feasible academic goals based on their learning history and recommend step-



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by-step methods to achieve them, according to Jin et al. (2023). This scaffolding is especially useful for Nigerian higher education students who lack academic planning and strategic learning expertise. AI links goal achievement with real-time feedback and progress visualisations, motivating users. Hooda et al. (2022) discovered that students are more inclined to persevere and adapt their techniques when they can observe their progress towards specified goals, such as understanding a concept or improving evaluation scores.

Due to overcrowded classrooms, inadequate instructor attention, and unclear academic objectives, Nigerian students typically lack motivation. Such systems can be very effective. AI systems' goal-setting functionality lets students define their own learning goals and receive AI-generated suggestions based on their performance and preferences. This balance between autonomy and supervision follows Nguyen et al. (2022)'s ethical AI implementation principles of learner empowerment, agency, and fairness. AI systems that enable individualized goal setting can democratize excellent learning in Nigeria, a country with educational disparity and uneven academic support.

Limitations of Rethinking Learner Autonomy in Nigeria through Artificial Intelligence

The infrastructural and digital divide in many Nigerian institutions makes using AI to promote learner autonomy difficult. AI's promise is recognised, yet many Nigerian universities struggle with internet connectivity, digital device access, power supply, and learning management systems (Petrie et al., 2020). Due to institutional issues, AI-enhanced platforms are not widely available to students, especially those in rural or impoverished universities. The preparedness and capacity of educators to meaningfully interact with AI technologies is another issue. According to Ayanwale et al. (2022), some Nigerian educators want to teach or utilise AI in classrooms, but many lack the skills, confidence, and pedagogical understanding to do so. Without well-prepared educators, AI-enhanced learner autonomy may be shallow or inconsistent, expanding the theory-practice divide.

Ethics are another important obstacle. Onyejebu (2023) warns that West African university curricula, notably Nigeria, lack consistent AI ethical integration, raising data privacy, algorithmic bias, transparency, and digital surveillance concerns. If students think AI technologies are obtrusive or untrustworthy, they may stop using them for self-directed learning. In weak or non-existent regulatory environments, ethical breaches could damage AI-driven education systems' credibility. The transition to autonomous, AI-enhanced learning is complicated by teacher-centred culture and pedagogy. In their study on library and information science educators, Oyetola et al. (2024) showed that many faculty are still adjusting to student autonomy and struggle to give up control. Innovative AI technologies for learner-driven education are delayed by institutional inertia and opposition to change.

Possibilities of Rethinking Learner Autonomy in Nigeria through AI

Though limited, AI's potential to reimagine learner autonomy in Nigerian higher education is enticing. AI can personalize learning at scale, adapt to learning styles, provide real-time feedback, and assist differentiated training. Bali et al. (2024) note that Nigerian institutions are testing AI trends like adaptive learning systems, intelligent tutors, and natural language processing applications, which could improve learner engagement and outcomes. AI can also fill gaps in learner assistance, especially in large, underfunded classrooms where kids get little attention. AI-driven analytics and automated tests give students rapid feedback and customized learning pathways, encouraging



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ownership. Nkwenti et al. (2023) support Africa's push towards open, flexible, and inclusive education by advocating for the strategic use of digital technologies to increase learner access and autonomy across varied contexts. When done publicly and with learner initiative, ethical AI development and deployment may build trust and engagement. AI Ethics and Higher Education (2022) recommends fairness, inclusion, and informed consent in AI application. If Nigerian schools include these concepts into their AI policies and practices, students may see AI as a tool that empowers rather than regulates their learning. Building local AI capacity is another option. Nigerian institutions can invest in AI technologies suited to local languages, curriculum, and pedagogy due to the present AI trend. Localized innovation boosts relevance, sustainability, and educational transformation ownership.

Conclusion

This study has illuminated the transformative potential of AI technologies in fostering learner autonomy through enhanced metacognition, goal setting, and self-regulated learning (SRL). Grounded in Zimmerman's Self-Regulated Learning Theory and Bandura's Social Cognitive Theory, the study has shown that AI can act as a personalized tutor, reflective partner, and motivational guide especially in educational contexts where traditional instruction fails to promote independent learning. However, the study also recognizes structural, pedagogical, and ethical limitations that must be addressed to fully harness the benefits of AI for Nigerian students. Despite infrastructural constraints, low digital literacy among educators, and ethical concerns around data privacy and equity, the findings indicate a significant opportunity to integrate AI tools to bridge learning gaps, increase learner agency, and modernize teaching and learning practices. If well implemented, AI can empower students to become autonomous, reflective, and goal-oriented learners, thus positioning Nigeria's higher education sector for global competitiveness.

Recommendations

Based on the findings and discussions, the following recommendations are offered:

1. Government and institutional stakeholders should prioritize investments in reliable internet access, modern computing facilities, and power supply to ensure that AI technologies can be effectively deployed across all higher institutions.
2. Universities should organize continuous professional development programs to equip lecturers and academic staff with practical skills for integrating AI tools into teaching, assessment, and student support in ways that promote learner autonomy and SRL.
3. Higher education curricula should include modules on AI literacy, ethical AI use, metacognitive strategies, and self-regulated learning to prepare students for independent, AI-enhanced learning.
4. Clear policies and ethical frameworks should be established to guide the responsible use of AI in education focusing on data privacy, transparency, bias mitigation, and student consent.
5. Nigerian institutions and EdTech developers should collaborate to design AI tools that align with local languages, cultural realities, and educational objectives to enhance relevance and student engagement.
6. Faculty should shift from traditional teacher-centred instruction to student-centred pedagogies that integrate AI tools, encourage goal-setting, and promote reflective practices.
7. Universities should create dedicated units or help desks that support students in navigating and using AI tools effectively for academic planning, self-monitoring, and feedback interpretation.



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8. AI-powered distance learning solutions should be deployed to extend quality learning opportunities to underserved areas, ensuring equity in access to AI-supported education.
9. Academic institutions should promote interdisciplinary research on AI applications in education and support pilot projects that evaluate their impact on student autonomy and learning outcomes.
10. Collaborations between universities, industry, government, and international organizations should be strengthened to provide technical expertise, funding, and policy support for sustainable AI integration in higher education.

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Correlation Between Office-Technology-Management and Managerial Skills Acquisition on sustainable Economic Development among Postgraduate Students in Tai Solarin University of Education, Ogun State, Nigeria

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Abstract

The study examined correlation between office- technology-management and managerial skills acquisition on sustainable economic development among postgraduate students in tai solarin university of education, Ogun state, Nigeria. Four research questions and a hypothesis were answered and tested. A descriptive survey research design was used. The population of this study comprised all Business Education postgraduate students in Tai Solarin University of Education, Ijagun, Ogun State. A total of 95 Business Education postgraduate student in Tai Solarin University of Education, Ijagun, Ogun State were selected as sample size of the study. Stratified sampling technique was used in the process of selecting the sample size. Researcher developed instrument tagged: Office Technology Management, Managerial Skills and Attainment of Sustainable Economic Development Questionnaire (OTMMSASEDQ) was used for data collection with reliability coefficient ($r = .91$). Research questions 1 and 2 were analyses using mean and standard deviation. Research questions 3 and 4 were answered using Pearson Product Moment Correlation (PPMC). Hypothesis was tested using multiple regression analysis. The findings of the study showed that digital, desirability, entrepreneurial, flexibility, risks management, prudence, digital marketing and time management skills ($2.77 > 2.50$) were among OTM skills for the attainment of sustainable economic development among other findings. It was recommended that Office Technology and Management undergraduates should embrace the provided opportunities in the programme and understudy the identified areas of entrepreneurial awareness for possible venturing towards their social and economic development.

Keywords: Office Technology & Management, Managerial Skills, Sustainable Economic Development

Introduction

Sustainable economic development is one of the goal all the nations in the world are seeking to achieved and sustained. It is a process that aims to meet the needs of the present while also preserving natural resources for future. It can take-place where majority of citizens who are capable and ready to work could secure one and has a stream of income to eradicate poverty and improve standard of living. One can say that; the attainment of sustainable economic development largely depends on the ability to reduce unemployment to the bearest minimum. The attainment of sustainable economic development is becoming paramount to the government and other stakeholders in Nigeria. Economic development is the key to higher living standards. It is connected to the developments in human capacity, the standard of living of the citizenry of a particular nation, the strength and buoyancy of its institutions and the overall societal well-being of its people. Evidence has shown that for a nation to attain development, its social, economic and political institutions must be in tandem with the Sustainable Development Goals (SDGs) and that within this framework, Nigeria is rated one of the developing countries with slow progress in education, gender equality, income equality, employment generation, wealth creation and poverty (Adeyemi & Owoye, 2024). Attaining sustainable economic development is one of the SDGs to be attained by year 2030. According to Amoda et al. (2020), sustainable economic development is the key to higher living standards and connected to the developments in human capacity, the standard of living of the



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citizenry of a particular nation, the strength and buoyancy of its institutions and the overall societal well-being of its people. For a nation to attain development, its social, economic and political institutions must be in tandem with sustainable economic growth and that within this framework. Economic development measures the actual standard of living of the people and the level of freedom they have to enjoy a good living condition. Simply defined, economic growth is the process whereby the total supply of goods and services of the society increase leading towards improved living standards. Economic growth is a multi-dimensional process involving major change in social structures, popular attitudes and national institutions as well as the acceleration of eco-growth, the eradication of poverty and reduction of inequality of wealth (Kurotimi et al. 2017). The end result of economic development is an increase in living standards, improvement in self-esteem needs and freedom from oppression, plus a greater choice.

Anyaehie and Areji (2015) defined economic development as a multi-dimensional process involving major change in social structures, popular attitudes and national institutions as well as the acceleration of eco-growth, the eradication of poverty and reduction of inequality of wealth. However, the end result of economic development is an increase in living standards, improvement in self-esteem needs and freedom from oppression, plus a greater choice. Measuring economic development is not as precise as measuring Gross Domestic Product (GDP), because it depends on what factors are included in the measurement. The most precise means to measuring economic development is the Human Development Index (HDI) which considers the educational level and pedigree of the people and their life expectancy which ultimately affects productivity and could lead to economic development. Anyaehie and Areji (2015) also opined that development involves the actualization of human potentialities, proper grasp, management of the environment and natural resources for sustained human well-being. Thus, the main goal of development is to meet human needs and aspirations. However, the major problem facing countries of the world on sustainable economic development is findings educated people in situation of unemployment.

Adeyemi and Owoye (2024) lamented that graduate's unemployment in Nigeria is major issue facing economic development of the country and that even if white-collar is not available, majority of these graduates find it difficult to commercialized the skills acquired in school to make a living. Adeyemi and Owoye (2024) believed that the disciplines of these graduates might have failed them in equipping saleable skills to be economically self-reliance should white-collar job are not coming. Office technology and management (OTM) is vocational studies that trained and equipped its recipients with saleable and office skills. Office technology and management programs have an obligation to equip students with the knowledge and abilities necessary to be employable, preventing credential holders from joining the industry with out-of-date and obsolete skills (Abdullahi et al. 2024). Fasae and Elemure (2008) stated that for a nation to be economically vibrant, every member of the populace must be fully capable of functioning and making a positive contribution to the growth and development of the nation's manpower production goal. They must also possess the necessary knowledge, skill, and attitude to effectively harness other resources and bring them into cooperative relationships, yielding the goods and services provided by the society to satisfy their needs and wants. Programs for office technology and management education are thought to be essential in helping the receivers develop their capacity for economic efficiency and effectiveness, which in turn advances national security. The winners' use of their vocational skills would support the growth and founding of other firms within the community, ultimately advancing security and national development.



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Office technology and management (OTM) are therefore intended to help its beneficiaries become responsible members of the community by refocusing attention from white collar professions to manipulative skills. Office technology and management programs can successfully empower the populace by preparing people for relevant, lucrative employment and lifelong learning. Empowerment eliminates poverty, increases work opportunities, improves life quality, and lessens the likelihood of social vices brought on by unemployment (Abdullahi *et al.*, 2024). Attainment of sustainable economic development through graduate employment which could be possible through the establishment of small and medium scale business is possible and this will go a long way towards reducing unemployment in Nigeria. However, It is not easy for small and medium entrepreneurs to find or develop a promising strategic path of organizational development when the ordinary business seems to attract almost all the available forces of the firm. Nevertheless, innovative potential and flexibility due to low formal complexity of the organization, closeness to the customer, independence from outside control and the deep impact of the owner on the business are typical attributes of small business firms (Banjo *et al.*, 2017).

Those with a managerial skill are often in a great position to succeed as entrepreneurs, except for two big misconceptions that lead to massive problems. Many today graduates believe that if a business is not working, the solution lies in hiring more employees. They throw extra bodies at the problem, but this may only aggravate the situation because it could fail to address the underlying root cause of the difficulty or lack of profitability. Another mistaken belief that is common to this mind-set is that the route to success is through growth, not profit growth but overall structural growth of the enterprise itself. Once again, bigger is not necessarily better unless and until the fundamentals are sound and efficient. Growing larger to fix the problems of a small business only generates a much bigger company with problems that are expanded, magnified, and much more expensive to remedy (Banjo *et al.*, 2017). The most misstep common to the managerial skill is that the entrepreneur wants to be the boss, even if that means sacrificing the talent or potential of employees. To give orders and be in charge requires no great skill or aptitude, but to be a leader, one who knows how to inspire and train others to rise to greater heights, is a rare quality. Graduates who become leaders succeed because they accept the challenge and responsibility of ensuring that others under their wings also succeed and flourish. By getting the most out of employees, graduates themselves are able to delegate aspects of their businesses to others and set higher goals. Those who say they cannot find good employees usually mean they lack what it takes to attract or create good employees and as a consequence they also lack what it takes to succeed as an entrepreneur. But those who not only manage but also lead can rise to the next level and become owners/leaders, one step closer to the real definition of an entrepreneur for unemployment reduction.

Statement of the Problem

Graduates' unemployment have been among the issues facing the Nigeria economic development. A situation whereby majority of the graduates cannot secure white collar job or become self-employed after years of graduation from school is pathetic and worrisome. It is believed that graduates of any tertiary institutions should possessed twin chances vis-à-vis, ability to secure white collar job or ability to be self-employed. However, the current situation of graduates including OTM graduates in Nigeria in terms of high unemployment and poverty level is pathetic and alarming. Government and other stakeholders in the economy have taking steps towards addressing the ugly situation through the introduction of compulsory Entrepreneurship Education into the curriculum of tertiary institutions with the aim to curb rate of graduates' unemployment. Despite that, the attainment of



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sustainable economic development remained a mirage in Nigeria as unemployment rates continue to increase among graduates. Thus, this study was an attempt to examine office technology and management (OTM) and managerial skills for the attainment of sustainable economic development.

Objectives of the Study

The objective of the study was to examine correlation between office- technology-management and managerial skills acquisition on sustainable economic development among postgraduate students in tai solarin university of education, Ogun state, Nigeria.

Specifically, the study sought to:

1. identify OTM skills for the attainment of sustainable economic development among postgraduate students in tai Solarin University of Education;
2. find out the managerial skills for the attainment of sustainable economic development among postgraduate students in tai Solarin University of Education;
3. examine the relationship between office technology and management (OTM) skills and attainment of sustainable economic development among postgraduate students in tai Solarin University of Education.
4. ascertain the relationship between managerial skills and attainment of sustainable economic development among postgraduate students in tai Solarin University of Education;
5. determine the joint contribution of relationships between office technology and -management (OTM) and managerial skills on attainment of sustainable economic development among postgraduate students in tai Solarin University of Education;

Research Questions

The following research questions guided this study:

1. What are the OTM skills for the attainment of sustainable economic development among postgraduate students in tai Solarin University of Education?
2. What are the managerial skills for the attainment of sustainable economic development among postgraduate students in tai Solarin University of Education?
3. Is there any relationship between office technology and management (OTM) skills and attainment of sustainable economic development among postgraduate students in tai Solarin University of Education?
4. Would there be relationship between managerial skills and attainment of sustainable economic development among postgraduate students in tai Solarin University of Education?

Hypothesis

The following null hypothesis was tested in this study:

HO₁: There is no significant joint contribution of relationship between office-technology and -management (OTM) and managerial skills acquisition on attainment of sustainable economic development among postgraduate students in tai Solarin University of Education.

Methodology

The study used a descriptive survey research design. The population of this study comprised all Business Education postgraduate students in Tai Solarin University of Education, Ijagun, Ogun State. A total of 95 Business Education postgraduate student in Tai Solarin University of Education, Ijagun, Ogun State were selected as sample size of the study. Stratified sampling technique was used in the process of selecting the sample size. Researcher developed instrument tagged: Office Technology Management, Managerial Skills and Attainment of Sustainable Economic Development Questionnaire (OTMMSASEDQ). The questionnaire (OTMMSASEDQ) requested responses on a four (4)



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– point scale format which was a modification of 5-point Likert scale. The questionnaire was divided into 2 sections vis-a-vis sections A and B. Section A focused on demographic characteristics of the respondents while sections B examined items regarding OTM skills, managerial skills and sustainable economic development. Face and content validity of the instrument were done on the instrument. A copy of the instrument was made available to the experts in the department to review in content, grammar and structure. Reliability of the instrument was done using the Cronbach alpha. In this case, copy of the instrument was administered on 12 business education postgraduate student in Olabisi Onabanjo University. The data that were collected subjected to Cronbach alpha formula to get reliability coefficient of the questionnaire and the reliability coefficient was reported as 0.91. Research questions 1 and 2 were analyses using mean and standard deviation. Research questions 3 and 4 were answered using Pearson Product Moment Correlation (PPMC). Hypothesis was tested using multiple regression analysis. Decisions were taken at 0.05 level of significance.

Presentation of Results

Research Question 1:

What are the OTM skills for the attainment of sustainable economic development among postgraduate students in tai Solarin University of Education?

Table 1: Mean and standard deviation on the OTM skills for the attainment of sustainable economic development

Items	Mean	SD
Digital skills	2.80	.899
Desirability skill	2.61	.990
Entrepreneurial skills	2.84	.995
Flexibility skills	2.59	.891
Risks management	2.69	.904
Prudency skills	2.54	.993
Digital marketing skills	2.92	.925
Time management skills	3.17	.752
Cluster Mean	2.77	

Source: Field Survey, 2025

Table 1 revealed that cluster mean was 2.77 and the bench mark mean was 2.50. Since, $2.77 > 2.50$, this implied that digital, desirability, entrepreneurial, flexibility, risks management, prudency, digital marketing and time management skills were among OTM skills for the attainment of sustainable economic development.

Research Question 2:

What are the managerial skills for the attainment of sustainable economic development among postgraduate students in tai Solarin University of Education?

Table 2: Mean and standard deviation on the managerial skills for the attainment of sustainable economic development

Items	Mean	SD
Effective planning skills	3.04	.700



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Organizing skills	2.88	.729
Resources allocation skills	2.62	.794
Goals setting achievement skills	2.92	.783
Self-motivation skills	2.78	.875
Self-engagement skills	2.73	.888
Promotional skills	2.84	.842
Cluster Mean	2.83	

Source: Field Survey, 2025

Table 2 showed that cluster mean was 2.83 and the bench mark mean was 2.50. Since, $2.83 > 2.50$, this implied that effective planning, organizing, resources allocation, goals setting achievement, self-motivation, self-engagement and promotional skills were among managerial skills for the attainment of sustainable economic development.

Research Question 3:

Is there any relationship between office technology and management (OTM) skills and attainment of sustainable economic development among postgraduate students in tai Solarin University of Education?

Table 3: Relationship between office technology and management (OTM) skills and attainment of sustainable economic development

Variables	Mean	SD	df	r-value	p-value
Sustainable economic development	18.96	2.29			
OTM skills	32.11	3.66	93	.114	.049

Source: Field Survey, 2025

From Table 3, it was observed that there was significant relationship between the independent variable and the dependent variable in the order of ($r = 0.114, p < .05$). On this premise, the researcher concluded that there was positive relationship between office technology and management (OTM) skills and attainment of sustainable economic development.

Research Question 4: Would there be relationship between managerial skills and attainment of sustainable economic development among postgraduate students in tai Solarin University of Education?

Table 4: Relationship between managerial skills and attainment of sustainable economic development

Variables	Mean	SD	df	r-value	p-value
Sustainable economic development	18.96	2.29			
Managerial skills	31.12	4.8	93	.317	.001

Source: Field Survey, 2025

From Table 4, it was observed that there was significant relationship between the independent variable and the dependent variable in the order of ($r = 0.317, P < .05$). On this premise, the researcher concluded that there was positive relationship between managerial skills and attainment of sustainable economic development.

HO₁: There is no significant joint contribution of relationships between office-technology and -management (OTM) and managerial skills acquisition on attainment of sustainable economic development among postgraduate students in tai Solarin University of Education.



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Table 5: Joint contribution of office technology and management (OTM) and managerial skills on attainment of sustainable economic development

Source of Variation	SS	df	MS	F-ratio	P
Regression	7.259	2	14.519	39.104	0.000
Residual	52.689	91	3.713		
Total	59.949	93			

Source: Field Survey, 2025

The table showed that there was significant joint contribution of independent variables (office technology and management (OTM) and managerial skills) on the dependent variable (attainment of sustainable economic development); $R = 0.648$, $p < .05$. The table further revealed {51.8% (Adj. $R^2 = 0.518$)} that about 52% of the variance in attainment of sustainable economic development was accounted for by the linear combination of the independent variables. The ANOVA results from the regression analysis showed that there was significant influence of the independent variables on the dependent variables.

Discussion of Findings

The findings of the study indicated that digital, desirability, entrepreneurial, flexibility, risks management, prudence, digital marketing and time management skills were among OTM skills for the attainment of sustainable economic development. It was also found that there was positive relationship between office technology and management (OTM) skills and attainment of sustainable economic development ($r = 0.114$, $p < .05$). These findings were in agreement with Adeyemi and Owoeye (2024) findings of the study revealed that management, risks management, information and communication technology (ICT), accounting, technical, communication, human relations, marketing, time management and innovativeness skills were among the required OTM skills for the attainment of sustainable economic development in South-West, Nigeria. It was also found that OTM skills, poverty and unemployment reduction directly related. Abdullahi, et al. (2024) showed that office technology and management education avail many opportunities that could enhance national security and sustainable development since it gives students marketable skills that they can use to find jobs after graduation and also assists in lowering Nigeria's unemployment rate. Ojo et al. (2024) revealed that risk taking, ICT, creativity, innovative, accounting, management, resourcefulness, distributive and leadership skills were among the required entrepreneurship skills for self-employment among postgraduates of business education. The analysis also revealed that technology, internet, problem solving, presentation, communication, typing and note-taking thinking, critical, attention-detail, customer service, effective time management, flexibility and adaptability skills were among the required OTM skills for self-employment among postgraduate students of business education. The analysis also revealed a significant relationship between entrepreneurship/OTM skills and self-employment opportunities among postgraduates of business education ($r = 0.740$, $p < .05$). The analysis further revealed that about 54% of the variance in self-employment opportunities among postgraduate students of business education was determined by the acquisition of entrepreneurship and OTM skills (54.3%, Adj. $R^2 = 0.543$). Orija and Jolaade (2018) concluded that skill acquisition in Office Technology and Management is a cornerstone for national and manpower development. It was recommended that management of every organization should employ Office Managers who had been trained to man offices so as to achieve set goals and objectives. Eze and Ononye (2021) revealed that problem solving skill, and database administration skills, are highly required of OTM graduates by small scale enterprises in Anambra State.



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Furthermore, the findings indicated that effective planning, organizing, resources allocation, goals setting achievement, self-motivation, self-engagement and promotional skills were among managerial skills for the attainment of sustainable economic development and that there was positive relationship between managerial skills and attainment of sustainable economic development $r = 0.317$, $P < .05$). These findings were in agreement with Iheukwumere (2024) finding revealed that organization and time management; confidentiality and professionalism; strong communication skill; teamwork and collaboration; analytical thinking and innovation; and leadership and social influence are the major soft skills needed by OTM graduates for globalized employability in the 21st century office. The study concluded that graduates in office technology and management can increase their productivity, job performance, and contribution to the organization's success by utilizing their soft skills. Oluwu and Aliyu (2015) found that managerial skills have significant impact on SSBs performance. The study concluded that inadequate managerial skills are factors militating against SSBs performance and recommended that government, Non-Government Organizations and SSB owners' unions should provide adequate training and development programmes to improve the managerial skills of SSB owners and their management.

Conclusion

This study has successfully examined correlation between office- technology-management and managerial skills acquisition on sustainable economic development among postgraduate students in tai solarin university of education, Ogun state, Nigeria.; the following conclusions were drawn based on the findings of the study that digital, desirability, entrepreneurial, flexibility, risks management, prudence, digital marketing and time management skills were among OTM skills for the attainment of sustainable economic development and there was positive relationship between office technology and management (OTM) skills and attainment of sustainable economic development. Effective planning, organizing, resources allocation, goals setting achievement, self-motivation, self-engagement and promotional skills were among managerial skills for the attainment of sustainable economic development and there was positive relationship between managerial skills and attainment of sustainable economic development.

Recommendations

Based on the findings of the study, the following recommendations are provided:

1. It was recommended that Office Technology and Management students must embrace the provided opportunity in the programme and acquire requisite entrepreneurial skills needed for the attainment of sustainable economic development.
2. Office Technology and Management undergraduates should embrace the provided opportunities in the programme and understudy the identified areas of entrepreneurial awareness for possible venturing towards their social and economic development.
3. The study recommended that government agencies and higher education administrators make sure that all OTM students have access to ICT facilities. Providing students with the necessary ICT skills will allow them to create simple flyers and memos, which can have an impact on communication between employers and employees, businesses and customers, and inter-business communications across physical boundaries.
4. Emphasis should be placed on the Office Technology and Management program to ensure that students acquire the necessary knowledge, skills, and aptitude to set up online video conferencing using Skype, Google Hangout, and Yahoo Messenger in the performance of office tasks such as filing, meetings, handling the phone, and handling mail which can all be completed quickly and precisely.



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5. The study also recommended, among others, that OTM curriculum should be constantly reviewed and updated to accommodate new skills needed by OTM graduates for self-employment.

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Impact of Adjustments on Academic Performance among Senior Secondary School Students in Jere Local Government Area of Borno State, Nigeria

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Abstract

This study investigated the Impact of Adjustments on Academic Performance of Senior Secondary School Students in Jere Local Government Area (LGA), Borno State, focusing on academic, social and emotional adjustments. Three (3) research questions were answered and 1 (one) hypothesis was tested in the study. Descriptive survey research design was used in the study. The target population for the study consists of all the 5,543 SS II and SS III senior secondary school students in Jere LGA. A sample of 500 students were selected using stratified simple random sampling technique in accordance with Krijcie and Morgan (1970). A researcher-developed questionnaire titled 'Students' Adjustments and Academic Performance Questionnaire (SAAPQ)' was used for data collection. The instrument was validated by three (3) experts in the field of educational psychology from University of Maiduguri and Borno State University. The instrument was pilot tested on 50 students and the reliability was calculated through test-retest method and reliability index of .76 was obtained. The instrument consists of four (4) sections and Eighteen (18) items. Data collected were analyzed using frequency count and percentage scores to assess the demographic information of students, descriptive statistics of (mean, standard deviation, frequency) to analyse the impact of adjustment on students' academic performance and t-test was used to assess the gender difference in adjustment and academic outcomes. The hypothesis was tested at the 0.05 level of significance using the Statistical Package for Social Science. The findings of the study revealed that academic, social and emotional adjustments significantly impact the academic performance of senior secondary school students in Jere LGA, Borno State. Based on the findings, the study recommended that Ministry of Education and SUBEB should enhance counselling services, life skills education, teacher training on psychosocial support and adjustments and increased involvement from parents, communities and NGOs to foster better adjustment and academic success

Keywords: Adjustment, Academic Performance & Students

Introduction

Student adjustment is a critical factor that influences academic success at various educational levels, particularly in senior secondary schools where learners are expected to balance personal, social and academic demands. Adjustment is the psychological process through which individuals navigate or respond to the demands and challenges presented by their environment (Santrock, 2018). Bhakta (2016) described adjustment as a method of creating appropriate responses to both internal and external stimuli; it represents the connection between a person's needs and their environment. Adjustment occurs when individuals achieve a state of balance between their needs and their level of satisfaction. School adjustment involves the process of adapting to challenging circumstances in order to meet the academic requirements within the school setting. Various components contribute to school adjustment, including academic performance, satisfaction with school, engagement in school activities, and pro-social behaviours (Bhakta, 2016). For students, effective adjustment encompasses several domains including academic, social and emotional adaptation, which collectively impact their ability to perform well in school (Afolayan, 2019). In the context of Nigerian secondary education, several studies have highlighted the importance of adjustment as a determinant of academic performance. In Jere LGA, students face a variety of adjustment challenges due to social, economic and regional factors. Individuals who face difficulties in adjusting, whether



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emotionally, socially or psychologically may encounter role confusion, which can lead to diminished self-esteem, a lack of concentration and ultimately negative impacts on academic performance. This suggests that the levels of personal and social adjustment are key indicators of academic achievement among adolescents (Erikson, 1968). Abubakar and Babayo, (2021), pointed out that, Maiduguri Metropolis has been affected by social unrest and economic instability, factors that may further complicate students' adjustment processes and academic trajectories. According to Yusuf and Adigun (2017), students who are better adjusted tend to exhibit more confidence, motivation, and resilience, all of which contribute to higher academic achievement. Conversely, poor adjustment has been linked to absenteeism, low academic engagement, and poor grades (Okoli & Obasi, 2020). Lakhani, Jain, and Chandel (2017) asserted that not being able to adapt can result in mental health problems. When students are well-adjusted, they are likely to be motivated to excel in their school activities, which can lead to strong academic performance. A child's ability to adjust significantly influences their academic outcomes. Conversely, maladjustment can have a severely negative effect on both the students' personalities and their academic success (Lakhani, Jain & Chandel, 2017). Furthermore, Subhash and Sangita (2017), pointed out that poor adjustment leads to low academic achievement, behavioural problems, irrelevant educational aspirations and even school dropout.

Paramo, Vacas, and Soledad (2015) discovered that students with poor academic and school adjustment performed worse academically than their peers with intermediate or higher adjustment levels and earned lower grades than those with moderate or greater adjustment levels. The degree of adjustment among students significantly influences their academic success. Gaining insights into students' adjustment and their relationship with academic performance is crucial for creating targeted support systems and interventions. This research therefore, examine how academic, social and emotional adjustments affect the academic performance of senior secondary school students in Jere LGA. By investigating this effect, the study aspires to enhance the existing knowledge that could guide educational policies and student support initiatives in regions impacted by conflict.

Statement of the Problem

Academic performance among senior secondary school students in Maiduguri Metropolis has become a growing concern for teachers, parents, school management and policymakers alike. Despite efforts to improve educational outcomes, a significant number of students continue to underperform, raising critical questions about the underlying factors influencing their academic success. One such factor, that is often overlooked, is the students' ability to adjust effectively to the complex demands of their academic and school environments. In a place like Maiduguri, marked by socio-political instability, displacement, and economic hardship due to insurgency, students are exposed to unique psychological and environmental stressors that can severely impact their adjustment processes. These challenges may manifest as poor academic motivation, difficulty in concentrating, strained peer relationships, or emotional distress, all of which can negatively affect academic performance. Yet, there remains a noticeable gap in empirical research examining how student adjustments-academic, social and emotional interact to influence academic performance of senior secondary school students in Jere LGA, Borno State. While studies in other regions have linked student adjustment to academic outcomes, little is known about how these dynamics play out in conflict-affected areas like Jere. Without this understanding, interventions aimed at improving student performance may fail to address the root psychological and social barriers hindering academic success. Therefore, this study seeks to fill that gap by investigating how adjustments among senior secondary school students in Jere LGA impact their academic performance. The goal is to provide



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evidence-based insights that can guide educational stakeholders in designing targeted support strategies to help students thrive despite adverse conditions.

Objectives of the Study

The objectives of the study were to determine the:

1. Impact of academic adjustment on the academic performance of senior secondary school students in Jere LGA, Borno State.
2. Influence of social adjustment on academic performance senior secondary school students in Jere LGA, Borno State.
3. Effect of emotional adjustment on the academic performance senior secondary school students in Jere LGA, Borno State.
4. Gender differences in students' levels of adjustment and their academic outcomes senior secondary school students in Jere LGA, Borno State.

Research Questions

To guide the study, the following research questions were addressed:

1. How does academic adjustment influence the academic performance of students in senior secondary school in Jere LGA, Borno State?
2. How does social adjustment impact students' academic performance in senior secondary school in Jere LGA, Borno State?
3. What is the effect of emotional adjustment on the academic performance of senior secondary school students in Jere LGA, Borno State?

Research Hypothesis

The following hypothesis was tested in the study:

H₀₁: Is there significant gender difference on impact of adjustments on academic performance among the senior secondary school students in Jere LGA, Borno State?

Research Methodology

This study used a descriptive survey design. This design is appropriate because it enables the researcher to gather data on the current levels of student adjustment and academic performance, and to analyze the impacts of these variables without manipulating any conditions. According to Cohen, Manion and Morrison (2007), survey among other things, gather data at a particular point in time with the intention of describing the nature of existing condition.

Population and Sample Size

The population for the study consists of all senior secondary school students in public secondary schools within Jere LGA, Borno State, the target population comprises of all the 5,543 SS II and SS III students in Jere LGA. This population is selected because they are at a critical stage of academic development and are likely to face varied adjustment challenges. The researcher randomly selected Eight (8) senior secondary schools in Jere LGA. The schools were first grouped into strata based on their geographical location within Jere LGA and then participants were randomly selected from each stratum. A sample of 500 students was selected using stratified random sampling to ensure representation across different classes and genders. The sample proportion is in accordance with Krijcie and Morgan (1970). The instrument used for data collection was a structured questionnaire titled "Students' Adjustment and Academic Performance Questionnaire (SAAPQ)". The questionnaire was designed by the researcher and validated by three (3) experts in the field of educational psychology from the University of Maiduguri and Borno State University, to ensure face and content appropriateness. To obtain the reliability of the instrument, a pilot study was conducted using 50 students from a school outside the study sample. Test-retest was used to obtain a reliability



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coefficient of .76, which was considered acceptable. The instrument has four (4) sections and total items of 18. Section A: elicits information on students' demographic data (e.g., age, gender, class level), section B: elicits information on academic adjustment, section C was on social adjustment while section D elicits information on emotional adjustment. The items in Sections B–D rated on a 4-point modified Likert scale and the response modes were Strongly Agree (4), Agree (3), Disagree (2) and Strongly Disagree (1). The researcher administered the questionnaire to the students in person with the help of two (2) trained research assistants. Prior consent was obtained from school authorities and students, and ethical considerations such as anonymity and confidentiality were strictly upheld. Data collected were analyzed using frequency count and percentage scores to assess the demographic information of students, descriptive statistics of (mean, standard deviation, frequency) to analyse the impact of adjustment on students' academic performance and t-test was used to assess the gender difference in adjustment and academic outcomes. The hypothesis was tested at the 0.05 level of significance using the Statistical Package for Social Sciences (SPSS).

Presentation of Results

Section A: Students Demographic Information

Table one: The Gender of the Participants

Gender	N	%
Male	250	50
Female	250	50
Total	500	100

Table one revealed that fifty (50%) of the participants were male while fifty (50%) were female.

Table two: Class Level of the Participants

Class Level	N	%
SS II	240	48
SS III	260	52
Total	500	100

Table two showed that forty eight percents (48%) participants were in senior secondary school two (SSII) while fifty-two (52%) were in senior secondary school three (SSIII).

Table three: School Types

Type of School:	N	%
Day	200	40
Boarding	300	60
Total	500	100

Table three indicated school types, forty (40%) of the participants were from day secondary school while sixty (60%) were from boarding secondary schools.

Research Question One: How does academic adjustment influence the academic performance of students in senior secondary school in Jere LGA, Borno State?

Table 4: Influence of Academic Adjustment on Students Academic Performance

S/N.	Item	N	Mean	SD	Decision
1.	I find it easy to concentrate in class	500	2.16	1.20	Rejected
2.	I complete and submit my assignments on time	500	2.68	1.25	Accepted



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3.	I plan and manage my study time effectively	500	2.51	1.21	Accepted
4.	I understand what is taught in most of my subjects	500	1.93	1.13	Rejected
5.	I find it easy to understand my teachers' explanations	500	2.64	1.18	Accepted
6.	I attend all my classes regularly and punctually	500	2.72	1.24	Accepted

Tabled 4 showed the participants responses on academic adjustment on academic performance off senior secondary school students in Jere LGA, Borno state. The result indicated that attending all classes regularly and punctually ranked highest among the impact of academic adjustment on students' academic performance, this was followed by completing and submitting assignment on time. While understanding what is taught in most of teaching subjects ranked the least.

Research Question Two: How does social adjustment impact students' academic performance in senior secondary school in Jere LGA, Borno State?

Table 5: Impact of Social Adjustment on Students Academic Performance

S/N.	Item	N	Mean	SD	Decision
1.	I find it easy to make new friends at school	500	2.53	1.13	Accepted
2.	I feel comfortable interacting with my classmates	500	2.72	1.82	Accepted
3.	I actively participate in group activities and discussions	500	2.58	1.16	Accepted
4.	I have a good relationship with my teachers	500	2.38	1.14	Rejected
5.	I feel accepted by my peers	500	2.52	1.15	Accepted
6.	My social relationships help me perform better academically	500	2.56	1.20	Accepted

Results presented in table 5 showed that social adjustment has significant impact on students' academic performance. This is due to the fact that all items with the exception of item 4, which stated that 'students have good relationship with teachers' have mean scores above the cut-off mark of 2.50.

Research Question Three: What is the effect of emotional adjustment on the academic performance of senior secondary school students in Jere LGA, Borno State?

Table 6: Impact of Emotional Adjustment on Students Academic Performance

S/N.	Item	N	Mean	SD	Decision
1.	I often feel anxious about my academic performance	500	2.53	1.21	Accepted
2.	I often feel overwhelmed by school work	500	2.67	1.29	Accepted
3.	I am able to control my emotions when I face challenges at school.	500	2.62	1.14	Rejected
4.	I feel confident in my ability to succeed in class activities	500	2.64	1.18	Accepted
5.	I feel emotionally balanced even during exams	500	2.74	1.15	Accepted
6.	I can manage academic stress without becoming overwhelmed	500	2.54	1.24	Rejected

Result in table 6 revealed the impact of emotional adjustment on students' academic performance. The result indicated that all items were accepted because their mean scores are above the cut-off



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mark of 2.50. This implies that, emotional adjustment has positive impact on students' academic performance.

H₀₁. Are there significant gender differences on impact of adjustment on academic performance among the senior secondary school students in Jere LGA, Borno State?

Table 7: t-test Scores of Gender Difference on Impact of Adjustments on Academic Performance of Senior Secondary School Students in Jere LGA, Borno State

	Gender	N	Mean	Std Dev.	df	t	P-Value	Decision
Impact of Adjustment on Academic Performance	Male	250	2.6640	1.07131	498	2.096	.037	Accept H ₀ P>.005
	Female	250	2.4600	1.10512				

Table 7 showed that the P-value .037 is greater than 0.05 level of significance with 498 degree of freedom, hence, the null hypothesis is accepted, this showed that, there is no significant difference in impact of adjustments on the academic performance of senior secondary school students in Jere LGA, Borno State.

Discussion of Findings

The research examined how academic, social and emotional adjustment affects the academic performance of senior secondary school students in Jere LGA, Borno State. The results of the research indicated that academic adjustment significantly impacts students' academic achievements positively in Jere LGA. Students who demonstrated effective time management, complete tasks assigned to them by their teacher, understand teachers' instructions and attend class regularly and punctually performed better academically. This aligns with recent research by Akintunde et al. (2023), who reported that students' ability to adjust academically predicts higher academic achievement, particularly in under-resourced or conflict-affected areas such as northeastern Nigeria. The study is also consistent with the findings of Okon et al. (2022), who reported that academic adjustment serves as a predictive factor for student performance in Nigerian secondary schools, especially in regions affected by socio-political instability. This implies that, in Jere LGA, where schools were affected by security challenges, students who maintain academic discipline and focus tend to perform more than their peers.

The study also showed that social adjustment is a crucial factor in impacting on academic performance of students. The findings indicated that students who were able to form new friends, interact with their peers in school, participate in group activities and build positive relationships with their classmates showed better academic performance. The study by Musa & Nwoke (2022) found a direct link between social integration and academic engagement among secondary school students in northeastern Nigeria. In conflict-affected areas like Borno State, social support networks among students can serve as buffers against external stressors, leading to improved concentration and motivation in academic tasks. Umar & Ibrahim (2023), also confirmed that peer group influence in Nigerian secondary schools significantly affects study habits, especially where parental involvement is minimal due to displacement or poverty. The study further aligns with the findings of Musa & Ibrahim (2021), who emphasized that social connectedness improves students' sense of belonging and participation in academic activities, even in conflict-affected areas. The results of the research indicated that emotional adjustment has a considerable effect on academic achievement. Students who exhibited self-confidence, emotional stability, self-discipline, and stress management



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skills tended to perform better academically compared to their classmates who lacked these traits. This observation aligns with the work of Bello & Zubairu (2024), who highlighted that emotional turbulence, including stress caused by trauma from conflict situations, can greatly influence students' academic success. In Jere LGA, students who received psychosocial support, Social and Emotional Learning or had coping mechanisms in place showed higher academic performance compared to their counterparts. According to Bello & Adamu (2023), students with emotional adjustment difficulties often exhibit poor academic concentration, low motivation and behavioural problems, which negatively impact academic performance. The findings of the study indicated that academic, social and emotional adjustments significantly impact the academic performance of senior secondary school students in Jere LGA, Borno State. The result showed that there is no significant difference in the impact of adjustments on the academic performance of senior secondary school students in Jere LGA. This finding is in agreement with Akomolafe and Olorunfemi (2017), who found that although male and female students exhibited differences in adjustment behaviours, these differences did not translate into significance difference in their academic performance.

Conclusion

The study on the Impact of Adjustments on Academic Performance of Senior Secondary School Students in Jere LGA, Borno State has revealed that adjustments in academic, social and emotional aspects are vital and interrelated factors affecting students' success in academics. The research found that students who can effectively handle their academic responsibilities, cultivate and sustain healthy social connections and manage their emotional reactions tend to achieve greater academic success, even in a difficult and conflict-impacted area like Jere LGA. Considering the specific circumstances of Jere LGA, which is affected by conflict, insecurity, and displacement, the ability of students to adapt successfully in the academic, social and emotional spheres is essential for their highest performance levels. The study validates that enhancing students' adaptability in these areas results in improved academic performance and greater educational resilience. The results also highlighted the importance of schools, government and community stakeholders in implementing comprehensive educational strategies that promote resilience and adjustments across all facets of student development.

Recommendations

Based on the findings, the following recommendations are proposed:

1. Ministry of Education and SUBEB should strengthen Guidance and Counselling Services in schools to support students' emotional and social adjustment. These Counsellors should offer regular sessions on stress management, emotional intelligence and trauma recovery, especially for students affected by conflict and displacement.
2. Educational authorities and policy makers should integrate structured life skills and adjustment programs into the school curriculum. These should cover time management, effective communication, goal setting, and coping mechanisms to improve both academic and social functioning.
3. Government through SUBEB and Ministry of Education should enhance teacher training on Life Skills, Psychosocial Support and Adjustment Programs in Jere LGA and should receive ongoing training in recognizing and responding to students' academic, social and emotional challenges. This will help them provide more responsive classroom management and foster a more inclusive learning environment.



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4. Schools should work closely with parents and community leaders to raise awareness about the importance of academic, emotional and social support for students. In areas affected by conflict, community involvement can bridge the gap created by broken family structures.
5. School administrators should establish systems to monitor students' adjustment and track academic performance regularly. Early identification of students with adjustment difficulties will allow timely preventive and curative intervention and support in schools.
6. Government and NGO should develop programs that support vulnerable students by providing educational materials, psychosocial support, scholarships, and school feeding initiatives to ease burdens on students and families.

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Effect of Reflective Teaching Approach on Achievement in Longitude and Latitude Among Secondary School Students in Bosso, Niger State

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Abstract

This study investigated the effects of reflective teaching approach on academic achievement in longitude and latitude among secondary school students in Bosso Local Government Area, Niger State. Two research questions and two null hypotheses were formulated, and tested at 0.05 level of significance. The study employed quasi-experimental research design, which comprises pretest, posttest, control and experimental group. The target population of the study comprised of 4478(2430Males; 2048 Females) SS II Students distributed over 17 public schools during the 2024/2025 academic session. Simple random sampling technique was used to select two schools, one school assigned as experimental group while the remaining one as control group, giving experimental group 135 (75 males; 60 females) students, whereas control group 120 (85 males; 35 females) students. The instruments for data collection was Longitude Latitude Achievement Test (LLAT) which covered the contents of longitude and latitude. developed by the researcher, and contain twenty (20) objective items with options A-D. LLAT is of two versions A and B. LLAT(A) is per-test and LLAT(B) is posttest which contained all items in LLAT(A) but has all its items reshuffled. Validation of the instruments were established by three experts. Test-retest was used to determine reliability, while PPMC was utilized to estimate the reliability coefficient and found to be $r = 0.83$. Mean, Standard deviation, Mean difference and Analysis of Covariance (ANCOVA) were statistical tools employed for data analysis. The result indicates that reflective teaching is more effective in improving students' performance in longitude and latitude concepts than conventional mode. Also, male students had a little academic mean gain than their female counterparts. Based on the findings, the followings recommendations were made, among others. Mathematics teachers should adopt using reflective teaching mode as alternative of conventional mode.

Keywords: Reflective, Conventional, Achievement, Mathematics, Longitude, Latitude

Introduction

Mathematics is the backbone of technological advancements and innovations, driving progress in fields like engineering and computing. Mathematics is an instrument for the development of science and technology. No nation can achieve meaningful scientific and technological development without solid foundation in school Mathematics (Asika, 2025). It is an academic subject that is crucial globally, and holds significant role in countries like Nigeria.



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Despite of the importance of Mathematics as one of major intellectual discipline taught at basic education and secondary school levels, researchers, mathematics educators revealed that there is high rate of poor achievement in the subject (Benjamin & Usman, 2019; Ahmad, et al., 2024). Achievement is defined as a measure of student's level of knowledge, skills or performance. It is an extent to which a student is profiting from lesson delivering in given task of learning, and that is reflected by the knowledge or skill has imparted to student. Ahmad (2024) described achievement as a yard stick for assessing learner's success or failure on a particular task, typically assessed as either high or low, corresponding to good or poor performance. It is an indicator to measure the extent has attained their short or long-term educational goals.

Research evidences shows that students have continuously recording low achievement as less than 42% of registered candidates obtained credits pass in Mathematics (Benjamin & Usman, 2019). Some contents of Mathematics have posed lots of challenges to students' academic achievement, these contents include: order of basic operations, directed number basically negative integers, bearing, logical reasoning, geometric constructions, trigonometric relations/values of angles, longitude and latitude. These contents in Mathematics curricula are found to be difficult to teach by teachers. And also found to be difficult to understand by students, which causes them to record failure in both internal and external examinations (Ameen & Salma, 2016). Reports from WAEC on students' poor achievement in Mathematics consistently in the Chief Examiners' reports from 2020 to 2024, the results demonstrate both progress and setbacks in Nigeria's educator. Many reasons levied against students' poor achievement in Mathematics as reported by some researchers, these reasons include: poor teaching methods, inadequate resources, teacher quality, Mathematics phobia, examination-related factors, gender disparities and socio-economic disparities (Ameen & Salma, 2016; Salma, 2018; Benjamin & Usman, 2019; Zakariyya & Ahmad, 2022).

In addition, as part of the attributed factor is that majority of Mathematics teachers still hold to using conventional/traditional teaching method in their class instructions. This method does not produce desired learning outcome, and it is teacher-centered which encourages teacher often talks to the students instead of creating opportunities for them to interact, discuss, ask question or sharing knowledge with their peers (Chinda et al., 2024). To address this problem, there is need to incorporate innovative instructional modes that would improve students' performance in Mathematics, especially longitude and latitude. Since longitude and latitude is identified as difficult topic. Longitude and latitude are vital topics in Mathematics and perceived difficult by students at senior secondary school level, that made study on it pertinent. The content has been consistent poor performance as submitted by the Chief Examiners' report from 2014 – 2025. Thus, this study will focus on content of longitude and latitude. Moreover, reflective teaching approach (RTA) is one of innovative teaching approach that combine methods utilized by teacher to translate a complex or an abstract theory in the classroom to a real-life reality based on experience in order to ensure that students understand what is taught easily (Chinda et al., 2024). Reflective teaching approach is a teachers' practice of critical analyzing their own teaching styles, methods and strategies to identify what works, what doesn't, and why, with intention of improving student performance and professional growth (Okigbo & Chukwunyelu, 2025). It is learner's centered that engages the students in series of questioning and thinking processes of self- regulation, self- evaluation, self – motivation and continuous improvement. These are done through researching the activities in the classroom, critically observing and evaluating the acquired information of the students' and teachers' themselves. Another scholar, Awodun (2020) defined RTA as an inquiry- based approach to teaching



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that involves critical thinking and a personal commitment to continuous learning and improvement, which create opportunity to construct their knowledge through interaction with peer without depending on teacher. RTA has the following key structures: self – analysis- the teacher systematically assesses or examine their lessons, asking their approaches and effectiveness of their instructions. Focus on improvement – working toward the setting goal to enhance student learning, develop more effective instructional strategies, and a more proactive role in the classroom. Professional development – the approach promotes on going learning and professional growth for the teacher, leading to increased confidence and a more proactive role in the classroom. All these are achieved through the following techniques, assertive question, thinking skill, scaffolding, oral discourse and collaborative learning. According to Awodun (2020) that RTA create conducive and meaningful learning environments for learners. It also provides rooms for teachers' professional growth and innovative teaching practices. He asserts that RTA generates the self-awareness of teachers in their teaching process that rather than teaching, making students to be self – directed learners who have accountability and commitment.

Types of Reflective Teaching Approach

To some scholars, like Kaung (2020) and Chinda et al. (2024) submitted that RTA are primarily classified as reflective-in- action, reflective- on- action and reflective-for- action. Reflective –in- action: This is thinking during the delivering of lesson. It is moment of reflection, where a teacher revisits their approach in real –time based on learner engagement or immediate problems. Reflective- on- action: This take place after a lesson or event, allowing the teacher to review the learning experience, analyze what work and what didn't, and identify areas of weakness and strength. Reflection- for – action: This kind of reflection is looking ahead, using insights from past reflections to plan for future tasks, and taking necessary adjustments to teaching practices ahead. These types of reflective teaching approach are implemented through practical approaches, like keeping a teaching journal, engaging in collaborative observations, conducting action research, seeking critical feedback from colleagues or analyzing student feedback. Chinda et al., (2024) commented that using RTA in class instruction improved classroom management, enhanced professional development and growth, and create positive and supportive rapport between teacher and students. In addition, RTA foster collaborative learning and also more adaptable and receptive to individual students' needs. Studies have been carried out in the past that are related to this study on effects of reflective teaching approach on students' academic achievement in longitude and latitude in different institutions of learning in Nigeria and world at large. The available ones to the researcher are reviewed in this study.

Mandy (2010) conducted research on using reflective practice in a Mathematics class, and reported that the practice enhances learning and can lead to deeper learning as learners use metacognitive practice to engage with their learning process. The study also revealed that reflection can improve the quality and depth of student learning by developing students' capacity to evaluate their learning and pass judgement in regards to the way forward. However, student found the practice very time consuming and could not always see any value in reflective writing in a Mathematics module. Nwoke (2015) explored impact of problem-solving approach on senior secondary school students' achievement in Mathematics. The findings revealed that the approach improve students' academic achievement in Mathematics and it is not gender bias. He maintained that teachers have to involve students in critical thinking and activities that will allow the students' participation for higher academic achievement. But Glory and Ihenko (2017) submitted that female students performed better than male students in science-based subjects. Furthermore, Benjamin and Usman (2019) commented that there is no significant difference in the mean achievement scores of male and female



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students taught longitude and latitude using improvised instructional materials and those taught with traditional teaching method. In another research work by Arslan, et al. (2012) reported that female students have more positive attitude than male counterparts towards learning Mathematics and had higher mathematics scores. Aliyu (2017) stressed that using innovative approaches that address different learning styles within instructional classrooms has been shown to encourages females' achievement in Mathematics. Also, study by Garba and Salim (2020) on effects of problem-solving on students' academic achievement in geometry. They reported that problem-solving strategy improve students' academic achievement better than traditional strategy, and also showed clearly that female students' outperform their male counterpart by having high mean score in the post test. Awodun (2020) investigated on the effects of reflective teaching strategy on students' academic performance and gender in secondary school Physics in Ekiti State. The findings revealed that reflective teaching strategy produced better achievement in students. In addition, there is no significant differences in the achievement measures of male and female students before and after treatment. Chinda, et al., (2024) submitted that reflective teaching approach enhanced professional growth, class management, create a positive and supportive rapport between teacher and students, foster collaborative learning. The reflective instructional strategy allows the teacher to evaluate their teaching to assist their students learn as much as possible, and using the approach are more adaptable and receptive to individual learner needs. Furthermore, reflective teaching is a sign of a caring teacher who can analyze the assumptions, values, and beliefs, underpin their methods of teaching.

Another study conducted by Okigbo and Chukwunyelu, (2025) on effects of reflective instructional strategy on secondary school students' achievement in Mathematics. The results revealed that students taught Mathematics using reflective instructional strategy achieved more than the students taught Mathematics using lecture method. They found that reflective instructional strategy is very effective in improving students' achievement in Mathematics when comparing with lecture method. Moreover, gender does not have significant effect on the achievement of students taught Mathematics using reflective instruction strategy and lecture method. In the research work conducted by Chukwunyela and Okigbo (2025) described reflective instructional strategy as learners' centered which engages learners to think deeply, discuss, collaborate and share their experiences together on a particular subject matter. They also reported that the use of reflective and flipped instructional strategies in secondary school improved their interest and performance in Mathematics, but does not have significant differences on gender. Some research works have shown that male students can perform better in innovative strategies than female students when they receive the right support, and vice-versa (Chinda, et al. 2024).

It is against this background, this present study tries to investigate effect of reflective teaching approach on academic achievement in longitude and latitude among secondary school students in Bosso Local Government Area of Niger State, Nigeria. The model on RTA is presented on following the steps and title Reflective Teaching Approach Lesson Model (RTALM): Plan the lesson, Class instruction, Reflection experience and refine the lesson instruction.

Statement of the Research Problem

The academic performance of students in Mathematics, especially longitude and latitude is consistently poor and has been an issue of interest to Mathematics educators and researchers. Most students cannot comprehend longitude and latitude content due to adherence to conventional teaching method, which does not promote meaningful learning of Mathematics as it appeals to



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hearing only, and favor the educational advantaged students (gifted, high ability) at detriment of the educationally disadvantages students (Zakariyya & Ahmad, 2022). To tackle these problems and fill in the gaps, this study proposes to investigate the effect of reflective teaching approach on academic achievement in longitude and latitude among secondary school students.

Aim and Objectives of the Study

This study investigated the effects of reflective teaching approach on academic achievement in longitude and latitude among secondary school students in Bosso Local Government Area, Niger State. Specifically, the objectives of this study are to:

1. determine the effect of reflective teaching approach on the students' academic achievement when taught longitude and latitude using reflective teaching approach and convention teaching method.
2. examine the effect of reflective teaching approach on academic achievement of male and female students when taught longitude and latitude.

Research Questions

The following questions were asked to guide this study. These are:

1. What is the difference between achievement mean scores of students taught longitude and latitude using reflective teaching approach and conventional teaching method?
2. What is the difference between achievement mean scores of male and female students taught longitude and latitude using reflective teaching approach?

Null Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significant.

Ho₁: There is no significant difference between achievement mean scores of students taught longitude and latitude using reflective teaching approach and conventional teaching method.

Ho₂: There is no significant difference between achievement mean scores of male and female students taught longitude and latitude using reflective teaching approach

Methodology

This study employed quasi-experimental research design, which comprises pretest, posttest, control and experimental group. This design is conducted in classroom experiment were control and experimental groups are naturally assembled as intact class or pre-existing group (Benjamin & Usman). The groups were tested with pretest to assess their homogeneity, thereafter they were exposed to treatment, and then tested with posttest to assess their academic performance. The target population of the study comprised four thousand, four hundred and seventy-eight SS II students (4478: 2430Males; 2048 Females) distributed over 17 public schools in Bosso Local Government Area. Through simple random sampling technique, two schools were selected out of 17, one school assigned as experimental group while the remaining one as control group. At second stage of randomization process in each of the school selected one intact class was selected, giving experimental group 135 (75 males; 60 females) students, whereas control group 120 (85 males; 35 females) students. The instruments for data collection for this study was Longitude Latitude Achievement Test (LLAT) which covered the contents of longitude and latitude. developed by the researcher, and contain twenty (20) objective items with options A-D. LLAT is of two versions A and B. LLAT(A) is per-test and LLAT(B) is posttest which contained all items in LLAT(A) but has all its items reshuffled. This reshuffle is to guide against familiarization of participants with arrangement pattern. Validation of the instruments were established by three experts from Federal University of Education Kontagora and Abdulkadir Kure University Minna. In addition, a pilot test was conducted to ascertain the effectiveness of the instruments. Test-retest reliability was used and PPMC was



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utilized to estimate the reliability coefficient and found to be $r = 0.83$. Mean, Standard deviation, Mean difference and Analysis of Covariance (ANCOVA) were statistical tools employed for data analysis.

Presentation of Results

Research Question 1

What is the difference between achievement mean scores of students taught longitude and latitude using reflective teaching approach and conventional teaching method?

Table 1: Means and Standard Deviations of Pretest and Posttest on Achievement Test

Group	N	Mean	SD	Mean	SD	Mean Diff.
Experimental	135	13.57	2.01	20.01	2.20	6.44
Control	120	12.83	1.40	14.18	4.07	1.35

From the data provided in Table 1, the experimental group which stands as those taught longitude and latitude with reflective teaching approach recorded a mean achievement score of 13.57 and a standard deviation of 2.01 in pretest, while a mean achievement score of 20.01 and standard deviation of 2.20 in posttest. The experimental group obtained a mean difference of 6.44 between pretest and posttest. The control group which represents those taught longitude and latitude with conventional teaching method obtained mean score of 12.83 and a standard deviation of 1.40 in pretest, while in posttest mean score reads 14.18 and a standard deviation of 4.07. The control group recorded a mean difference of 1.35 between pretest and posttest. This resulted to mean gain of 5.09 in favor of experimental group. The result thus indicates that reflective teaching is more effective in improving students' performance in longitude and latitude concepts than conventional mode.

Hypothesis One: There is no significant difference between achievement mean scores of students taught longitude and latitude using reflective teaching approach and conventional teaching method.

Table 2: Results of Test between Experimental and Control Group in Posttest

Source	Type III Sum of Square	Df	Mean Square	F	Sig
Corrected Model	1987.563	2	988.779	363.631	.000
Intercept	570.677	1	570.677	218.513	.000
Pretest	600.063	1	600.013	180.366	.000
Groups	1326.320	1	1326.320	194.277	.000
Error	548.417	252	2.75	452.645	
Total	47246.000	255			
Corrected Total	2446.000	254			

Results in Table 2, shows that main effect was significant at 0.05 level of significance, thus the null hypothesis of no significant difference in the mean achievement scores of students taught longitude and latitude with reflective teaching approach and conventional teaching method is hereby rejected. Since the P-value (.000) is less than 0.05. Therefore, there is significant difference in the mean achievement score of students taught longitude and latitude using reflective teaching approach and conventional teaching method.

Research Question Two

What is the difference between achievement mean scores of male and female students taught longitude and latitude using reflective teaching approach?

Table 3: Means and Standard Deviations of Pretest and Posttest on Genders

Group	N	Mean	SD	Mean	SD	Mean Diff.
Male	75	12.54	3.61	15.90	1.61	3.36
Female	60	11.78	2.82	13.87	1.52	2.09



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The data in Table 3 revealed that male students recorded mean achievement score of 12.54, with standard deviation of 3.61 in pretest. While, in posttest mean achievement score is 15.90 and with standard deviation of 1.61. The mean difference between pretest and posttest is 3.36. Moreover, the female students had mean achievement score of 11.78, with standard deviation of 2.82 in pretest. While, in posttest mean achievement score is 13.87, with standard deviation of 1.52. The mean difference between pretest and posttest is 1.27. However, to establish the statistically significant, ANCOVA was applied to test the null hypothesis.

Hypothesis Two: There is no significant difference between achievement mean scores of male and female students taught longitude and latitude using reflective teaching approach

Table 4: Results of Test of Male and Female Students in experimental Group

Source	Type III Sum of Square	Df	Mean Square	F	Sign
Corrected Model	86.438	2	23.766	56.736	.000
Intercept	823.726	1	823.726	1580.872	.000
Pre-test	74.088	1	74.088	123.207	.000
Gender	3.268	1	3.268	4.775	.061
Error	54.612	132	.646		
Total	30906.000	135			
Corrected Total	132.000	134			

From above in Table 4, P-value = 0.061 which is greater than 0.05. This implied that there is no significant difference in the mean achievement scores of male and female students taught longitude and latitude using reflective teaching approach is hereby retained.

Discussion of Findings

The results in Table 1 and 2, revealed that the reflective teaching approach had better performance when comparing to conventional teaching method evidenced by a high achievement mean score, which was found to be significant. This finding agreed with the results of Mandy (2010), Chinda, et al. (2024) and Okigbo and Chukwunyelu, (2025). They reported that reflective teaching approach is learner’s center which engages active participation, thinking deeply, discussion and collaboration which brings better performance in Mathematics. It also improved classroom management, create a positive support and rapport between teacher and students, and enhanced professional development and growth of the teacher. From the data in Table 3 and 4, male students had a little academic mean gain than their female counterparts. The findings confirm the results of Awodun (2020), Chukwunyela and Okigbo (2025) and Okigbo and Chukwunyelu, (2025) that gender does not have significant effect on the achievement of male and female students when taught Mathematics using reflective teaching approach. But this contradicts the findings of Arslan et al (2012) and Garba and Salim (2020) on that showed clearly that female students have more positive attitude towards Mathematics learning and outperform their male counterpart by having high mean scores. They reported that gender has significant difference on students’ achievement.

Conclusion

According to the reflective teaching lesson model, which involves deeper thinking, keeping a teaching journal, engaging in collaborative observations and learning, conducting action research and seeking critical feedback from colleagues or analyzing student feedback. Students taught longitude and latitude using the RTA model had higher scores than their peers academically. The study also, revealed that there was no discernible difference in the achievement mean scores of male and female students who were taught longitude and latitude using reflective teaching mode.

Recommendations

The following recommendations were made:



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1. Professional organizations such as STAN, MAN, NERDC and others should include Reflective teaching approach into their workshops, seminars and conferences to train Mathematics teachers on how to use reflective teaching approach.
2. Mathematics teachers should adopt using reflective teaching mode as alternative of conventional.
3. Curriculum planners should incorporate reflective mode into Mathematics curriculum

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Influence of Computer-Based Facilities and Entrepreneurship Training on Job Productivity among Tertiary Institution Secretarial Staff in Ogun State, Nigeria

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Abstract

The study examined the influence of computer-based facilities and entrepreneurship on job productivity of secretarial staff. Three hypotheses were tested for the study. A descriptive survey design was used. The population of the study covered 225 secretaries in Tai Solarin Federal University of Education, Ijagun, Olabisi Onabanjo University, Ago-Iwoye and Tai Solarin College of Education (TASCE), Omu-Ijebu, Ogun State respectively. Since population of the study is not large, therefore, there was no need for sampling. Researcher's developed instrument; tagged: 'Computer-Based Facilities, Entrepreneurship and Secretarial Staff Job Productivity Questionnaire (CBFESSJQ)' with reliability coefficient ($r = .88$) was used for data collection. Regression analysis was used to test all the hypotheses. The findings revealed that there was positive influence of computer-based facilities ($\beta = .220$, $t = 3.362$, $p < .05$) and entrepreneurship (entrepreneurial mindset) ($\beta = .207$, $t = 3.152$, $p < .05$) on secretaries' job productivity in tertiary institutions in Ogun State. It was also indicated that there was a significant combined influence of explanatory variables on secretaries' job productivity in Ogun State $R^2 = 0.445$, $P < .05$ and that about 19% of the variance in secretaries' job productivity were accounted for by the linear combination of the explanatory variables. The study recommended that the necessary office technology equipment should be provided in every organization and training and retraining programme should be organized for secretaries in every organization for occupational relevance. There is urgent need for secretaries to be equip with entrepreneurial mindset.

Keywords: Computer-Based Facilities, Entrepreneurship, Job Productivity, Secretarial Staff.

Introduction

In many organization, secretarial staff represent categories of employees that are germane towards goal attainment of the system. Secretarial staff perform administrative and clerical support to ensure an organization's smooth operation. Their duties often include managing schedules, handling correspondence, preparing documents, maintaining filing systems, and serving as the first point of contact for visitors and callers. They use skills in organization, communication, and time management to support executives and colleagues. The productivity of secretarial staff drives vision of the organisation and that secretarial staff productivity is the measure of their efficiency and output in performing administrative, organizational, and support tasks. Modern secretaries, also known as administrative or executive assistants, are integral to a company's success by ensuring smooth operations, freeing up executives' time, and acting as a central hub for communication. Akintunde (2023) mentioned that factors such as availability of modern facilities, training, promotion as well as entrepreneurship training were among determinants that drives secretarial staff job productivity; while Adebayo and Akinyele (2022) said increment in staff productivity in this modern era is influence



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by many factors such as availability and utilization of modern facilities. Most recently, businesses or organization have developed word processing centres and relied on personal computers and even electronic mail in an effort to lessen the need for secretarial support and make the employee-secretary very productive (Akpomi & Ordu, 2019). As a result of changes in technology, the role of secretarial staff in organization particularly tertiary institutions has changed tremendously from that of typewriting and shorthand dictation, answering of telephone calls and processing of mails. Today's secretaries are exposed to office technology including the internet that makes work much easier and knowledge more accessible (Edwin, 2023). It is now easier to send messages by telex, electronic mails (e-mails), fax and telephones. Other office gadgets available to the secretary are photocopy machines, duplicating machines, dictating machines, printers, among others. This is the era of computers and information technology which has become an enabler of greater convenience (Safarudin et al., 2020).

Furthermore, computer-based facilities includes computer software programme, word processing, help the user to write and edit memos, letters and reports, data management programmes or databases, help the user-secretary to use long lists of data and spreadsheet programmes, handle tables and numbers, secretaries now have many technologically advanced office gadgets to ease their jobs and enhance proficiency and productivity leading to improved access to goods and services globally (Akpomi & Ordu, 2019). Also, there are wide ranges of office computer-based facilities which now enable secretaries to improve their performances. Such new facilities take the form of electronic typewriters that have replaced the manual ones. Word processors with multi-purpose facilities, computers and other sophisticated office machines and equipment are now provided by employers. Also, some of the physical computer-based facilities used by secretaries include computer communication equipment and electronic pocket organizers. New technological facilities that have altered the procedures and technique for office functions include the computers, electronic mail/commerce, voice mail, and the Internet (Edwin, 2023).

According to Chukwumezie (2022), computer-based facilities are physical spaces or assets that use computer technology, such as data centers with servers and networking equipment, and systems that rely on computers for management and operations. A common example is [Computer-Aided Facility Management \(CAFM\)](#) software, which uses IT to help manage physical buildings and assets by streamlining tasks like space planning, maintenance scheduling, and energy monitoring. This technology allows for more efficient, data-driven, and cost-effective operations by integrating software solutions with physical infrastructure. Duniya (2021) said computer-based facilities offer secretarial staff significant benefits, including improved efficiency, enhanced communication, and higher-quality output. By automating repetitive tasks, computer facilities enable secretaries to take on more complex, administrative duties, increasing their value to the organization. Computer-based facilities streamline daily tasks, allowing secretaries to complete work more quickly and with fewer errors. Word processing software eliminates the need for manual retyping, while automated tools handle routine tasks like report generation and data entry. Computer-aided systems can automate the processing, storage, and distribution of information, allowing for a smoother and faster workflow. By using digital tools, secretarial staff can deliver services and documents more quickly, greatly increasing turnaround times. Another factor predicting secretarial job productivity is what Mumuni and Hawa, (2024) called entrepreneurship through entrepreneurial-mindset. An entrepreneurial mindset can influence secretarial staff productivity by transforming their approach to work, enabling them to become more proactive, resourceful, and innovative. By adopting key entrepreneurial traits, a secretary can move beyond traditional administrative tasks to become a more strategic and efficient



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contributor to the office. Instead of waiting for instructions, a secretary (secretarial job productivity) with an entrepreneurial mindset anticipates the needs of their manager and the organization. This proactive approach allows them to address potential issues before they arise and take the initiative to streamline workflows, boosting efficiency for everyone. Davies (2023) secretaries with an entrepreneurial spirit look for better, smarter, and faster ways to get work done. They may suggest and implement new technologies or processes, improving overall office operations and showing they are valuable, resourceful professionals. An entrepreneur's success relies on efficient use of time and resources, skills that are directly applicable to a secretarial role. This mindset helps a secretary prioritize tasks effectively, minimize distractions, and manage multiple projects at once to meet deadlines and optimize their output.

Furthermore, as stated by Nonye (2023), entrepreneurship emphasizes the importance of building strong relationships with clients, suppliers, and partners. For a secretary, this translates to developing exceptional communication skills and a robust network within and outside the company. This enables them to find needed resources, facilitate smoother interactions, and represent the organization professionally. While a secretary is not expected to take the financial risks of an entrepreneur, an entrepreneurial mindset encourages the professional to take calculated risks to improve processes. This might involve adopting a new, unproven software program or suggesting a change in office procedure that, if successful, could save significant time or money. An entrepreneurial employee feels a sense of ownership over their work and the organization's success. This increased accountability means a secretary is more likely to go the extra mile, ensuring the quality of their work and taking responsibility for the outcome. This level of commitment directly enhances overall office productivity. Ntukidem (2020) opined that as modern tools enhanced secretaries job productivity likewise a secretarial professional with a growth mindset will seek out training opportunities to acquire new skills, such as mastering new software or staying current on industry trends. This willingness to learn and adapt ensures they remain a valuable asset to the office. However, the theoretical framework for this study relied on Technology Acceptance Model (TAM) which was developed by Davis, Bagozzi and Warsaw (1989) as an information systems theory. The model is based on how users come to accept and use technology in terms of facilities. The theory was adopted from the Theory of Reason Action (TRA) which was developed by Ajzen & Fishbein (1980). TRA was designed to explain virtually any human behaviour and it consists of two factors that affect human skills. TAM models suggest that when users are faced with new technological challenges due to innovation in computer-based facilities. By assuming other variables are constant, the easier the technology to be used, the higher and its possibility to be adopted by users. The characteristics of secretaries' user are grouped within the individual context; the technological context refers to the characteristics of the technology itself; while the implementation context refers to the specific professional environment of the user. Davies (2009) believed that using particular computer facilities will enhance job performances and productivity. It is also indicating general determinants of secretary acceptance of innovation in computer-based facilities and can be applied to explain or predict secretary behaviours across a broad range of user computing technology.

The relevance of this theory to the current study was that the Technology Acceptance Model (TAM) provides a framework for understanding how secretarial staff adopt and use new office technologies, which directly affects their productivity. The model posits that two main factors, perceived usefulness and perceived ease of use, influence a person's intention to use a technology and their ultimate adoption of it. Perceived usefulness (PU) is the degree to which a user believes that a particular



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technology will enhance their job performance. For secretarial staff, the perceived usefulness of new software or office equipment is crucial for boosting productivity. If secretaries perceive new technology, such as automated scheduling software or a document management system, as useful, they will use it. This adoption can streamline administrative tasks, reduce processing times, and minimize human error, leading to higher efficiency. A perception that technology can automate routine tasks like data entry or filing increases the likelihood that secretarial staff will embrace it. This allows them to focus on more complex, strategic responsibilities, thereby enhancing their overall contribution. When secretaries believe, new technology can help produce better quality work—for example, by using advanced software for presentations or detailed reports—they are more likely to integrate it into their workflow. Perceived ease of use (PEOU) is the degree to which a user believes that using a particular system will be free of effort. For secretarial staff, a low barrier to use encourages adoption and increases productivity. Secretaries are more likely to adopt and consistently use a new system if its interface is intuitive and requires minimal learning effort. If a new system is difficult to master, it can hinder productivity rather than help it.

Statement of the Problem

Many changes and reforms in office automation are increasing on daily basis and this is making the work of secretaries more challenging. In recent times, there has been tremendous technological advancement in computer-based facilities in the world of information and communication technology that has thrown challenges to practicing secretaries in tertiary institutions. In the face of this technological advancement in computer-based facilities, the old tools and techniques which comprised manual typewriters, stencil duplicators and stencil cutting machine, used by secretaries have become obsolete, for the modern secretarial functions. One of the main issues is how to keep in pace with the changes and a lack of an entrepreneurial mindset hurt a secretary's job productivity by fostering a reactive instead of a proactive approach. This leads to missed opportunities for efficiency and innovation, poor problem-solving, and a failure to anticipate needs. The entrepreneurial mindset, conversely, equips administrative professionals with traits like initiative, adaptability, and creativity, which are critical for excellence in a modern office. The researcher by experience and observation found that many of the secretaries in tertiary institutions seem to find it difficult to confidently operate the computer and other computer-based facilities and resources. Consequently, some secretaries are faced with the problems of acquiring additional and relevant skills which entails huge sums of money and time, the opportunity to be retrained and ability to adapt to these changes in technology is the hallmark of a modern successful secretary and it is on this note that this study sought to examine the influence of computer-based facilities and entrepreneurship on job productivity of secretarial staff.

Objectives of the Study

The main objective of the study was to examine the influence of computer-based facilities and entrepreneurship on job productivity of secretarial staff. Specifically, the study sought to examine:

1. Influence of computer-based facilities on secretaries' job productivity in Ogun State;
2. Influence of entrepreneurship (entrepreneurial mindset) on secretaries' job productivity in Ogun State;
3. The combined influence of explanatory variables on secretaries' job productivity in Ogun State.

Hypotheses

H₀₁: There is no significant influence of computer-based facilities on secretaries' job productivity in Ogun State.



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Ho₂: There is no significant influence of entrepreneurship (entrepreneurial mindset) on secretaries’ job productivity in Ogun State.

Ho₃: There is no significant combined influence of explanatory variables on secretaries’ job productivity in Ogun State.

Methodology

This study adopted descriptive survey design. The population of the study covered all the secretaries in Tai Solarin Federal University of Education, Ijagun, Olabisi Onabanjo University, Ago-Iwoye and Tai Solarin College of Education (TASCE), Omu-Ijebu, Ogun State respectively. Thus, TASUED has 57 secretaries (in which 16 are confidential secretaries, 16 are typist and 25 are computer operator); OOU has 154 secretaries (in which 23 are secretaries, 117 are secretaries’ assistants and 14 are computer operator) while TASCE has 14 secretaries (in which 7 are confidential secretaries and also the remaining 7 are secretaries assistants) which makes the total population of the study to be 225 secretaries. Since population of the study is not large, therefore, there was no need for sampling. The study used researcher’s developed instrument; tagged: ‘Computer-Based Facilities, Entrepreneurship and Secretarial Staff Job Productivity Questionnaire (CBFESSJQ)’. The instrument requested responses on a four (4) – point Likert Scale format; such as Strongly Agreed (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The initial drafts of the instrument were subjected to face validity by three experts from Business Education Department of the same institution. Each of the experts was served with the instrument and requested to rework, delete or add items as they consider appropriate. In order to ensure the reliability of the instrument, a test-retest study was carried out. The instruments were administered twice within two weeks interval among 15 secretaries different from the study area. Thus, the test-retest reliability method was used to determine the reliability coefficient. The data that generated was correlated using Pearson Product Moment Correlation. The outcomes for reliability coefficient was reported as (r = .88). The respondents (secretaries) were briefed on the purpose of the study and clarifications were made on the importance of the study. The researcher ensures that the questionnaire was filled correctly as the respondents were assured of the confidentiality of their responses through the use of three research assistants. Regression analysis was used to test all the hypotheses. For regression analysis, when p value is less than significance level (p < .05), the null hypotheses are rejected, otherwise, accepted.

Presentation of Results

Ho₁: There is no significant influence of computer-based facilities on secretaries’ job productivity in Ogun State.

Table 1: Influence of computer-based facilities on secretaries’ job productivity in Ogun State

Model	Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.
	B	Std. Error			
(Constant)	18.401	1.890		9.733	.000
1 Computer-based facilities	.162	.048	.220	3.362	.001

a. Dependent Variable: Secretaries’ job productivity

The first important thing to note in table 1 was that the sign of the coefficient of computer-based facilities is positive. This implied that secretaries’ productivity increase with increase in computer-based facilities. Thus, null hypothesis was rejected and concluded that there was a positive significant influence of computer-based facilities on secretaries’ job productivity in Ogun State ($\beta = .220, t = 3.362, p < .05$).



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Ho₂: There is no significant influence of entrepreneurship (entrepreneurial mindset) on secretaries' job productivity in Ogun State.

Table 2: Influence of entrepreneurship (entrepreneurial mindset) on secretaries' job productivity in Ogun State

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	20.466	1.367		14.974	.000
	Entrepreneurial mindset	.134	.043	.207	3.152	.002

a. Dependent Variable: Secretaries' job productivity

The first important thing to note in table 2 is that the sign of the coefficient of entrepreneurial mindset is positive. This implied that secretaries job productivity increase with increase in entrepreneurial mindset. Thus, null hypothesis was rejected and concluded that there was a positive significant influence of entrepreneurship (entrepreneurial mindset) on secretaries' job productivity in Ogun State ($\beta = .207$, $t = 3.152$, $p < .05$).

Ho₃: There is no significant combined influence of explanatory variables on secretaries' job productivity in Ogun State.

Table 3: Combined influence of explanatory variables on secretaries' job productivity in Ogun State

Source of Variation	SS	Df	MS	F-ratio	P
Regression	676.037	2	225.346		
Residual	2739.412	221	12.396	18.180	.000 ^b
Total	3415.449	224			

Dependent variable: Secretaries' job productivity

Table 3 showed that there was a significant combined influence of explanatory variables on secretaries' job productivity in Ogun State $R^2 = 0.445$, $P < .05$ which implied rejection of null hypothesis. The table further revealed {18.7% (Adj. $R^2 = 0.187$)} that about 19% of the variance in secretaries' job productivity were accounted for by the linear combination of the explanatory variables. The ANOVA results from the regression analysis showed that there was significant of the influence of independent variables on the dependent variables; $F(2, 221) = 18.180$, $P < .05$.

Discussion of Findings

The finding of this study revealed that there was a positive significant influence of computer-based facilities on secretaries' job productivity in Ogun State. That is, secretaries productivity increase with increase in computer-based facilities. These finding correlates with Safarudin et al. (2020) who examined result revealed that computer-based facilities have significant effect on job productivity, behaviour and performance of secretaries. Mumuni and Hawa (2024) who examined the effects of modern office technology on the performance of office secretaries in the Upper West Region of Ghana. Their findings of the study revealed that knowledge on use of office equipment contributed positively to productivity. This is reinforced by the percentages, mean and standard deviations. It was also established that office gadgets availability had no relationship with its knowledge. The percentages, means and standard deviations also reinforce this claim.

The study findings revealed that there was a positive significant influence of entrepreneurship (entrepreneurial mindset) on secretaries' job productivity in Ogun State. These findings were in



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tandem with Nonye (2023) who found that entrepreneurship emphasizes the importance of building strong relationships with clients, suppliers, and partners, that a secretary translates to developing exceptional communication skills and a robust network within and outside the company. This enables them to find needed resources, facilitate smoother interactions, and represent the organization professionally. Mumuni and Hawa, (2024) concluded that entrepreneurial mindset influences secretarial staff productivity by transforming their approach to work, enabling them to become more proactive, resourceful, and innovative.

Finally, computer-based facilities and entrepreneurship jointly influence secretarial staff job productivity and the findings were in consonant with Akpomi and Ordu (2019) who found that computer-based facilities includes computer software programme, word processing, help the user to write and edit memos, letters and reports, data management programmes or databases, help the user-secretary to use long lists of data and spreadsheet programmes, handle tables and numbers, secretaries now have many technologically advanced office gadgets to ease their jobs and enhance proficiency and productivity leading to improved access to goods and services globally as well as Nonye (2023) who found that entrepreneurship emphasizes the importance of building strong relationships with clients, suppliers, and partners for secretaries for job productivity.

Conclusion

Having examined the influence of computer-based facilities and entrepreneurship on job productivity of secretarial staff, based on the findings, the following conclusions were made that there was positive influence of computer-based facilities, entrepreneurship (entrepreneurial mindset) on secretaries' job productivity in tertiary institutions as well as the combined influence of explanatory variables on secretaries' job productivity in Ogun State.

Recommendations

In line with the findings of the study, the following recommendations are provided:

1. The study recommends that training in the use of modern office equipment be intensified to increase the knowledge level of secretaries and subsequently their productivity.
2. It is recommended that the necessary office technology equipment should be provided in every organization and training and retraining programme should be organized for secretaries in every organization for occupational relevance.
3. It is recommended that institution of higher learning should endeavour to send secretaries to more computer technology/application workshops to update their knowledge and skills to make them relevant and IT compliant.
4. Modern office technological gadgets should be procured and made available for use by secretaries to enable them increase their productivity and move with innovation and trends in the global world.
5. There is urgent need for secretaries to be equip with entrepreneurial mindset.

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Assessment of Technological Advancement on Classroom learning Engagement among Public Secondary School Students in Ijebu-ode Local Government Area of Ogun State, Nigeria

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Abstract

The study was an assessment of technological advancement on classroom learning engagement among public secondary school students in Ijebu-ode Local Government Area of Ogun State, Nigeria. A descriptive research design of survey type was used. The population for this study comprised public secondary school students in Ijebu Ode local government, Ogun State. Out of 13 public secondary schools in Ijebu-ode local government area, a simple random sampling technique was used in selecting 4 representing 31%. This technique gave equal chance for the all 13 schools to be included in the sample size. Sample size was 182 students. Researcher developed questionnaire; titled: Technological Advancement and Students Learning Engagement Questionnaire (TASLEQ) was used for data collection with reliability 0.81. Mean and standard deviation were used for analyzing research questions. The findings of the study showed among others that there was medium level of students learning engagement in secondary school. Lack of funds from the government side, inadequate infrastructure development in school, resistance to change on the part of teachers, cybersecurity concerns and insufficiency skills on the part of teachers and students were among the issues confronting technological advancement in students learning engagement. It was concluded that the provisions of adequate resources for technological advancement installment in school and provisions of infrastructure development in school are needed for students learning engagement. The study recommended that policy makers and educational stakeholders to prioritize the integration of technology in curriculum development and teacher training programs.

Keywords: Technological Advancement, Teacher, Learning Engagement.

Introduction

Student learning engagement refers to the degree of attention, curiosity, interest, and passion students show when learning, encompassing their motivation and active participation in the learning process. Student engagement is about how actively and meaningfully students participate in their learning, encompassing their emotional, behavioral, and cognitive involvement. The dimension of student learning engagement could take the forms cognitive, affective and behavioural engagements. Cognitive engagement involves students' intellectual effort, strategic thinking, and willingness to tackle challenging ideas. Affective engagement refers to students' emotions, feelings, and attitudes towards learning, the subject matter, and the learning environment as well as behavioral



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engagement: includes observable behaviors like participation in class, effort, persistence, and concentration. Shaurya (2024) believed that the notion of student engagement is multifaceted, encompassing components of learning that are cognitive, emotional, and behavioral. Because it can provide immersive, interactive learning experiences that accommodate a variety of learning preferences and styles, technology has the potential to increase student engagement. Students can actively participate in the learning process through multimedia presentations, gamified learning exercises, and collaborative online tools. This increases their motivation, interest, and involvement in academic assignments. The introduction of technology has brought about a profound change in the educational environment. Technology may help create a more engaging learning environment, interactive tools, simulations, and multimedia materials can turn passive learning into an active experience. Kumar and Akram (2019) stated that the beneficial effects on a number of student engagement characteristics, such as social, behavioral, reflective, and cognitive. As noted by Shaurya (2024), technology offers content through visuals, audio, and kinesthetic exercises to accommodate a variety of learning styles and that online platforms encourage students to collaborate and learn from one another by facilitating communication.

Technological advancement is an important part of students' lives. Incorporating technology into the classroom has proved to be beneficial yet also has some drawbacks. Technology has helped student willingness and engagement and allows for the enhancements of learning (Kaite, et al 2021). The need for engagement means that the best types of learning will be those that involve choices that the student can make and learning where there are meaningful contexts where the student is engaged. Technological advancement can also improve learning results by giving users access to a multitude of resources and information outside the usual classroom lecture and textbook boundaries. With the internet acting as a massive knowledge base, students may perform research, go in-depth with topics, and obtain educational materials catered to their specific learning requirements. Furthermore, tailored learning environments and adaptive learning technology can accommodate each student's individual learning styles and aptitudes, enabling differentiated instruction and enhanced academic outcomes. Notwithstanding the possible advantages, there are drawbacks and issues to take into account when analyzing how technology affects learning outcomes and student engagement. Technological obstacles, information overload, and digital diversions are a few problems that might prevent students from learning effectively and from making academic progress. Furthermore, discrepancies in students' access to technology and level of digital literacy can deepen the digital gap and worsen already-existing inequities, creating problems for educational equity. Given these intricacies, it is imperative to carry out thorough study in order to comprehend the subtleties of technology's impact on learning outcomes and student engagement (Kumar & Akram, 2019). Interestingly, technology integration in education plays a pivotal role in transforming traditional teaching and learning approaches, offering myriad of benefits to both educators and students. This integration enhances the learning experience by facilitating interactive, personalized, and engaging instruction (Ally, 2020). One significant advantage of technology integration is its ability to cater for diverse learning styles and individual student needs (Bingimlas, 2022). Through multimedia resources, interactive simulations, and adaptive learning platforms, technology provides opportunities for differentiated instruction, allowing educators to tailor lessons to the unique requirements of each student. Furthermore, technology advancement integration fosters the development of critical 21st-century skills, such as digital literacy, problem-solving, collaboration, and creativity (Puentedura, 2021). By leveraging on digital tools and online resources, students



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acquire the technical proficiencies necessary for success in today's digital age while honing essential skills for lifelong learning engagement (Gyamfi & Mensah, 2021).

Moreover, technology-enhanced learning environments promote active engagement and student-centered approaches, shifting the role of educators from disseminators of information to facilitators of inquiry-based learning. Interactive whiteboards, educational software, and online collaboration platforms empower students to take ownership of their learning, fostering independence, curiosity, and intrinsic motivation (Gyamfi & Mensah, 2021). Furthermore, technology integration expands access to educational opportunities, breaking down geographical barriers and enabling remote learning experiences (Hodges et al., 2020). Particularly in contexts with limited resources or infrastructure challenges, digital tools and online platforms provide avenues for equitable access to quality education, bridging the gap between urban and rural communities (Gyamfi & Mensah, 2021). Hence, technology advancement integration in education offers numerous benefits, including catering for diverse learning needs, fostering 21st century skills development, promoting active engagement, and expanding access to educational opportunities. In the Nigerian education system, the integration of technology advancement faces numerous challenges and barriers that hinder its effective implementation. Infrastructure limitations pose significant obstacles, including inadequate access to electricity, limited internet connectivity, and insufficient hardware and software resources (Uzodinma et al 2024). Additionally, the digital divide exacerbates disparities in technology access and usage, particularly among different socioeconomic groups and between urban and rural areas (Nwachukwu, 2018). Socioeconomic disparities and gender inequalities persist, with girls often having less access to technology resources and opportunities compared to boys. Limited teacher capacity and training are significant barriers, as many educators lack the necessary skills and support to effectively integrate technology into their teaching practices (Aluko, 2024). Resistance to change and traditional teaching practices further inhibit technology adoption among teachers.

Curriculum misalignment and pedagogical challenges hinder the integration of technology advancement into instructional practices, with inadequate integration of technology-related competencies into the curriculum and resistance to pedagogical shifts (Agunbiade, 2018). Financial constraints, including limited budget allocations and high costs of technology, pose significant barriers to technology integration initiatives (Uduji & Okolo-Obasi, 2022). Cultural perceptions of technology, language barriers, and policy inconsistencies further complicate technology integration efforts. Addressing these challenges requires comprehensive strategies that address infrastructure limitations, provide adequate teacher training and support, align curriculum and pedagogy with technology integration goals, secure sufficient funding, and address cultural and societal factors that influence technology adoption in education. The current state of technology integration in the Nigerian education system reflects both progress and persistent challenges. Recent efforts have aimed at leveraging on digital tools and resources to enhance teaching and learning experiences. Initiatives include the establishment of computer labs, provision of digital textbooks, and the adoption of online learning platforms. Government policies have also been developed to support technology integration, aiming to narrow the digital gap and equip pupils with essential skills for the modern world. However, significant hurdles remain, such as inadequate infrastructure, limited access to technology and internet connectivity, and a shortage of trained educators proficient in technology use. Disparities in technology access across regions and socioeconomic groups exacerbate existing inequalities. Addressing these challenges requires sustained investment in technology infrastructure, comprehensive teacher training programs, and the development of locally relevant digital content. Additionally, promoting digital literacy and responsible technology use is



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crucial for ensuring equitable access and maximizing the potential impact of technology integration on educational outcomes in Nigeria.

Statement of the Problem

In the context of education in Nigeria, there exists a pressing need to evaluate the effectiveness of integrating technology advancement to enhance learning engagement. This assessment is crucial due to the growing emphasis on leveraging technological tools and resources to improve educational practices. However, despite concerted efforts to integrate technology into teaching and learning processes, there remains a significant gap in understanding its impact and the specific challenges encountered within the Nigerian educational landscape. Key issues such as inadequate infrastructure, limited access to technology resources, insufficient teacher training, and disparities in technology adoption among different regions and socioeconomic groups, and the necessity to align technology integration with curriculum objectives pose formidable barriers. These challenges collectively impede the realization of the full potential of technology advancement to elevate learning engagement for students in secondary school education in Nigeria. Addressing these obstacles is paramount to harnessing the benefits of technological advancement integration and improvement in students learning engagement. Hence, the study examined the influence of technological advancement on students learning engagement.

Objectives of the Study

The main objective of the study was to examine the influence of technological advancement on students learning engagement. Specifically, the study sought to:

1. determine the level of students learning engagement in secondary school;
2. ascertain the issues confronting technological advancement in students learning engagement;
3. identify strategies towards resolving issues facing technological advancement in students learning engagement;
4. find out the role of technological advancement towards enhancing students learning engagement.

Research Questions

The following research questions guided this study:

1. To what level are students learning engagement in secondary school?
2. What are the issues confronting technological advancement in students learning engagement?
3. What are the strategies towards resolving issues facing technological advancement in students learning engagement?
4. What are the role of technological advancement towards enhancing students learning engagement?

Research Method

The study adopted a descriptive research design of survey type. This design is considered very appropriate because the researcher intended to collect data from the selected respondents to provide answer to the study objectives. The population for this study comprised public secondary school students in Ijebu Ode local government, Ogun State. However, a total of 13 public secondary schools were in Ijebu-Ode local government areas. Out of 13 public secondary schools in Ijebu-ode local government area, a simple random sampling technique will be used in selecting 4 representing 31%. This technique will give equal chance for the all 13 schools to be included in the sample size. Those schools selected are Ijebu-Muslim College, Luba Comprehensive High School, Adeola Odutola College and Ijebu-ode Grammar School. From Ijebu-Muslim College 41 teachers were selected, from Luba Comprehensive High School 49 teachers were selected, from Adeola Odutola College 51 teachers were selected and from Ijebu-ode Grammar School 41 selected were selected using stratified



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sampling technique. Sample size was there 182 teachers. The study used researcher developed questionnaire; titled: Technological Advancement and Students Learning Engagement Questionnaire (TASLEQ). The questionnaire (TASLEQ) requested responses on a four (4) – point scale format which will be a modification of 5-point Likert scale. The responses rating scales are as follows: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The questionnaire divided into two sections A and B. Section A focus on demographic characteristics of the respondents, while section B focused on the related items on the level of students learning engagement; issues confronting technological advancement in students learning engagement; strategies towards resolving issues facing technological advancement in students learning engagement and the role of technological advancement towards enhancing students learning engagement. The initial draft of the instrument was subjected to face and contents validity by experts from the department of Educational Technology. All the issues raised were duly attended to in order to ensure its content, construct, and criterion validity. To ensure the reliability of the instrument, a test-retest reliability of the instrument was carried out. The copies of the instrument were administered to a sample of 20 teachers in a separate school outside the geographical scope of the study. The purpose is determined the stability and consistency of the instruments. Pearson Product Moment Correlation (PPMC) was used to determine the level of reliability coefficient which yielded 0.81 as reliability coefficient. Data were collected using the validated instrument. Introduction letter was presented to the authority of the selected public secondary schools seeking their permission to administer the questionnaire. The researcher personally administered the questionnaire with the help of 3 research assistants to the respondents. The researcher ensured that respondents are adequately briefed on the content and procedure for filling the questionnaire. Enough time was given to the respondents to respond to each item in the questionnaire. Mean and standard deviation were used for analyzing research questions. Any mean score of 2.5 and above regarded as agree while any one below 2.5 regarded as disagreed.

Presentation of Results

Research Question 1: To what level are students learning engagement in secondary school?

Table 1: Mean and standard deviation responses on the level are students learning engagement in secondary school

Items	Mean	SD
My students always present in during teaching.	2.68	.905
Students participated in classroom discussion.	2.95	.849
Students always asked questions from me.	3.02	.699
Most of the students failed to asked questions in classroom.	3.22	.704
Students are immersed in work that has clear meaning and immediate value to them.	3.16	.677
Average Mean	3.01	

Source: Field Survey, 2025

Table 1 revealed that average mean was 3.01 which greater that bench mark mean value 2.50. This implied that there was medium level of students learning engagement in secondary school.

Research Question 2:

What are the issues confronting technological advancement in students learning engagement?

Table 2: Mean and standard deviation responses on the issues confronting technological advancement in students learning engagement

Items	Mean	SD
Lack of funds from the government side.	2.77	.887
Inadequate infrastructure development in school.	2.59	.906
Resistance to change on the part of teachers.	2.75	.905



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Cybersecurity concerns	2.65	.899
Insufficiency skills on the part of teachers and students.	2.83	.875
Average Mean	2.72	

Source: Field Survey, 2025

Table 2 showed that average mean was 2.72 which greater that bench mark mean value 2.50. This implied that lack of funds from the government side, inadequate infrastructure development in school, resistance to change on the part of teachers, cybersecurity concerns and insufficiency skills on the part of teachers and students were among the issues confronting technological advancement in students learning engagement.

Research Question 3: What are the strategies towards resolving issues facing technological advancement in students learning engagement?

Table 3: Mean and standard deviation responses on the strategies towards resolving issues facing technological advancement in students learning engagement

Items	Mean	SD
Provisions of adequate resources for technological advancement installment in school.	2.83	.953
Provisions of infrastructure development in school	2.91	.904
Training for teachers on the need for technological advancement integration in education.	2.85	.999
Provisions of ant cybersecurity treats.	3.11	.888
Provision of motivation technique such as scholarship for students with higher learning engagement.	2.92	.832
Average Mean	2.92	

Source: Field Survey, 2025

Table 3 showed that average mean was 2.92 which greater than bench mark mean value 2.50. This suggested that provisions of adequate resources for technological advancement installment in school, provisions of infrastructure development in school, training for teachers on the need for technological advancement integration in education, provisions of ant cybersecurity treats, and provision of motivation technique such as scholarship for students with higher learning engagement were among the strategies towards resolving issues facing technological advancement in students learning engagement.

Research Question 4: What are the role of technological advancement towards enhancing students learning engagement?

Table 4: Mean and standard deviation responses on the role of technological advancement towards enhancing students learning engagement

Items	Mean	SD
Providing interactive and personalized learning experiences.	3.23	.772
Fostering collaboration	3.16	.794
Offering access to a vast array of resources	3.06	.755
Ultimately preparing students for the digital age	3.28	.775
Foster student engagement for auditory and visual learners.	2.99	.720
Average Mean	3.14	

Source: Field Survey, 2025

Table 4 showed that average mean was 3.14 which greater than bench mark mean value 2.50. The implications of these results were that providing interactive and personalized learning experiences, fostering collaboration, offering access to a vast array of resources, preparing students for the digital age and foster student engagement for auditory and visual learners were among the role of technological advancement towards enhancing students learning engagement.



Discussion of Findings

The findings of the study revealed that there was medium level of students learning engagement in secondary school. These findings correlate with Ghanbaripour et al. (2024) whose findings revealed that these technologies significantly enhance student engagement by providing immersive and interactive learning experiences that bridge the gap between theoretical knowledge and practical application. Furthermore, their use is shown to improve learning outcomes by facilitating a deeper understanding of complex concepts and increasing student motivation. In terms of employability, the integration of digital tools into education equips students with the requisite skills that are increasingly demanded in the modern workplace. However, the study also identifies several challenges, including high costs, limited resources, and the need for extensive faculty training, which act as barriers to the effective implementation of these technologies. Juan (2024) found that these tools, ranging from interactive apps to online platforms and virtual simulations, have been found to enhance student motivation and participation. Study demonstrated that students using digital tools showed increased levels of attentiveness and active participation compared to traditional classroom settings. This engagement often stems from the interactive nature of digital tools, which allow for personalized learning experiences tailored to individual student needs and interests. Furthermore, digital learning tools foster collaborative learning environments by facilitating peer interaction. and group projects, as highlighted in a meta-analysis by Johnson and Lee (2019). This collaborative aspect not only improves social skills but also encourages students to take ownership of their learning process. Additionally, digital tools provide immediate feedback mechanisms through quizzes, assessments, and real-time analytics, enabling teachers to gauge student comprehension and adjust instructional strategies accordingly.

The findings also showed that lack of funds from the government side, inadequate infrastructure development in school, resistance to change on the part of teachers, cybersecurity concerns and insufficiency skills on the part of teachers and students were among the issues confronting technological advancement in students learning engagement. These findings correlate with Shaurya (2024) looks at the possible advantages of technology, such as enhanced capacity for knowledge retention, critical thinking, and problem-solving. The initiative also recognizes the difficulties that come with integrating technology, including the digital divide, potential diversions, and the requirement for well-thought-out educational tactics. Through the examination of these variables, the study hopes to offer insightful guidance to teachers who are looking to use technology to improve learning outcomes and increase student engagement. Uzodinma et al. (2024) findings of the study revealed a notable positive correlation between technology integration and learning outcomes among pupils in childhood and primary education, emphasizing technology's potential to enrich educational effectiveness in these contexts. Moreover, the findings of the study also identified discrepancies in the extent of technology integration across schools, highlighting the necessity for tailored interventions to mitigate inequalities and narrow the digital gap among pupils.

The findings further indicated that the provisions of adequate resources for technological advancement installment in school, provisions of infrastructure development in school, training for teachers on the need for technological advancement integration in education, provisions of ant cybersecurity treats, and provision of motivation technique such as scholarship for students with higher learning engagement were among the strategies towards resolving issues facing technological



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advancement in students learning engagement. These findings were in agreement with George and Ige (2022) showed that ICT tools were available but not adequate for academic engagement. In addition, the available ICT tools were not used frequently and coupled with the inadequacy of the tools, its effect was not felt much. It was also found that use of the available ICT tools influenced the lecturers to introduce new innovation in teaching, which in turn facilitates smooth delivery of instructions and saves time and energy. Respondents also identified the challenges facing the use of ICT tools to include inadequate funding to procure ICT infrastructure and modern ICT tools, lack of supervision, unstable network and power supply and lack of policy on ICT use in the university system. Kaite et al. (2021) findings showed that more training for teachers and students are necessary to better implement technology in the classroom. Usman (2021) revealed a positive perception of technology integration among educators, with high mean scores indicating strong understanding and favourable attitudes towards technology-integrated curriculum resources. However, variability exists in specific beliefs and practices, highlighting the need for targeted professional development and policy support. Moreover, while students perceive technology integration positively for aspects like assignment completion and curiosity, there are lower ratings for making learning exciting and connecting to subjects. The study underscores the significance of addressing socioeconomic, cultural, and infrastructural factors in promoting effective technology integration and recommends investments in infrastructure, comprehensive professional development, clear policy frameworks, collaborative partnerships, and ongoing research to enhance technology-enhanced education in Sokoto State. Chuchan (2018) revealed the existence of significant relationship between students' academic performance and their computer literacy as well as students' technology utilization and their family income. Data showed that student's academic performance is highly influenced by the teacher's effective teaching and by the teacher's computer literacy nor by their competence in technology. Grade 7 students of private and public schools utilize technology the least while fourth year students utilize technology the most. No significant difference was found on self-efficacy among year levels.

Smith and Johnson (2019) findings from the study indicated a significant increase in student engagement levels among those using digital simulations, as evidenced by higher participation rates and increased interest in the subject matter. Students expressed enthusiasm for the interactive nature of the simulations, which allowed them to visualize complex concepts and experiment with different scenarios. This engagement translated into improved learning outcomes and a deeper understanding of physics principles. Jones (2020) revealed a notable increase in student motivation and engagement in the gamified group, leading to improved learning outcomes and deeper understanding of mathematical concepts. Students reported enjoying the competitive elements, immediate feedback, and rewards incorporated into the gamified platform, which incentivized active participation and problem-solving. Garcia and Martinez (2018) observed that the use of mobile learning apps increased student engagement through interactive exercises, personalized learning experiences, and immediate feedback mechanisms. Students appreciated the flexibility and accessibility of mobile apps, allowing them to learn at their own pace and engage with multimedia content that catered to different learning styles. Furthermore, the gamification elements embedded within some apps enhanced motivation and sustained interest in language learning.

Finally, the findings depicted that providing interactive and personalized learning experiences, fostering collaboration, offering access to a vast array of resources, preparing students for the digital age and foster student engagement for auditory and visual learners were among the role of



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technological advancement towards enhancing students learning engagement. These findings corroborate with Miller and Anderson (2022) found that students using VR simulations exhibited higher levels of engagement, curiosity, and retention of biological concepts compared to those using traditional methods. The immersive and interactive nature of VR simulations allowed students to explore complex biological phenomena in a controlled yet realistic environment, fostering curiosity and deeper understanding. Students reported feeling more motivated to learn and participate actively in laboratory activities when using VR simulations. Brown and White (2021) observed that online collaborative tools facilitated communication, teamwork, and active participation, leading to increased student engagement and higher-quality project outcomes. Students appreciated the real-time collaboration features, which allowed them to work together seamlessly, share resources, and provide feedback to peers. Anderson and Clark (2023) found that digital annotation tools improved student engagement by encouraging active reading, critical thinking, and collaborative discussions among peers. Students appreciated the ability to annotate texts digitally, which facilitated deeper comprehension, analysis, and reflection on literary themes and characters.

Conclusion

The study examined the influence of technological advancement on students learning engagement, the following conclusions were drawn based on the findings of the study that there was medium level of students learning engagement in secondary school; lack of funds from the government side, inadequate infrastructure development in school, resistance to change on the part of teachers, cybersecurity concerns and insufficiency skills on the part of teachers and students were among the issues confronting technological advancement in students learning engagement; provisions of adequate resources for technological advancement installment in school, provisions of infrastructure development in school, training for teachers on the need for technological advancement integration in education, provisions of ant cybersecurity treats, and provision of motivation technique such as scholarship for students with higher learning engagement were among the strategies towards resolving issues facing technological advancement in students learning engagement and providing interactive and personalized learning experiences, fostering collaboration, offering access to a vast array of resources, preparing students for the digital age and foster student engagement for auditory and visual learners were among the role of technological advancement towards enhancing students learning engagement.

Recommendations

Based on the findings of the study, the following recommendations are provided:

1. Policymakers and educational stakeholders to prioritize the integration of technology in curriculum development and teacher training programs.
2. The study recommended that the university administrators should liaise with TETFUND to provide ICT infrastructures such as modern ICT tools, broadband access that will facilitate speedy internet access as well as alternative power supply to resolve the challenges of unstable power supply for enhanced academic engagement.
3. Furthermore, school administrators should sensitize and encourage teachers to use tutorial hours for effective academic engagement where necessary to resolve the challenge of limited hours allocated to courses.
4. Integrating interactive digital tools into curricula to enhance student engagement, particularly in complex topics where visualization aids comprehension and concept retention.



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5. Gamified platforms to enhance student engagement, especially for topics that students may find challenging or abstract, as the gamification elements were found to increase intrinsic motivation and sustained interest in learning engagement.

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Effect of Jigsaw Strategy on Performance in Plane-Shapes Concept among Secondary School Students in Zuru Metropolis of Kebbi State, Nigeria

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Abstract

This study investigates the effect of Jigsaw instructional strategy on performance in plane-shapes concept among junior secondary school students in Kebbi State, Nigeria. The study was guided by two research questions and hypotheses. The researcher adopts pretest-posttest quasi-experimental research design. A sample of one hundred and twenty-eight (128) JSS II Students, purposively selected from a population of one thousand four hundred and fifty-seven (1457) students in the study area drawn from two out of 11 mixed gender public secondary schools within Zuru Metropolis. Data were collected using Plane-shapes Performance Test (PPT) with $r = 0.73$. The researcher employed descriptive statistics to answer the research questions and t-test statistics at 0.05 alpha level to test the null hypotheses. The study also aims to ensure the correct implementation of Jigsaw teaching strategy in mathematics classroom through exemplification. Moreover, the study highlights the purpose, basic steps, teacher and student tasks, as well as the advantages and disadvantages of Jigsaw teaching strategy in addition to comparing and briefly explaining the six distinct yet related types of Jigsaw instruction strategies. Research findings revealed that the Jigsaw instructional strategy has a significant positive effect on students' performance in plane-shape concepts and equally gender friendly. Therefore, the Jigsaw instructional strategy does improve not only the academic outcomes of secondary school student, but also promotes equity and inclusivity across gender, thus becoming a valuable tool for diverse classrooms.

Keywords: Performance, Jigsaw Strategy, Plane-Shapes Concept, Mathematics & Students

Introduction

In recent years, teaching strategies are gradually shifting away from the traditional teacher-centered approach towards a student-centered approach. Chu (2014) states that studies involving cooperative learning have emerged as an internationally important area among researchers. The Jigsaw method is a cooperative learning strategy first developed by Elliot Aronson in 1971 and further advanced in assessment practices by Robert Slavin in 1986. Aronson invented this teaching method called (Jigsaw) since it resembles the game (Jigsaw) as a means of assisting students of different cultural backgrounds to minimize the severity of ethnic tensions and also overcome learning gaps in the then-desegregated schools in Austin, Texas (Hamadneh, 2017). Teachers everywhere have been utilizing this strategy and its various components to promote collaboration in secondary through post-secondary classroom settings (Hance, 2016). Several studies investigated the effects of the jigsaw strategy on students' interest and achievement in Mathematics and found that the jigsaw strategy is gender friendly, and improves students' interest and achievement in Mathematics. Timayi, Bolaji, and Kajuru (2015) reveals that students taught using J4CLS performed better than students taught using conventional method. Gender performance was unaffected. The study found the J4CLS gender-friendly and effective for teaching and learning geometry. Areelu and Ladele (2018) reveals that the jigsaw method, gender, and socioeconomic status increase senior secondary students' interest in mathematics. Anaduaka, Olaoye, and Sunday (2018) reveals that Jigsaw-taught students had much higher mean achievement than conventionally-taught students. Jigsaw-taught boys and girls performed similarly. Yemi, Azid, and Ali (2018) indicates that the teaching of mathematics via the Jigsaw strategy is more effective than the traditional teaching method in increasing academic



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achievement. Okafor and Nwosu (2021) showed that: there was a significant difference in the mean achievement scores of students taught using the jigsaw strategy and those taught using the lecture technique; gender had no significant effect on student accomplishment in mathematics when exposed to the jigsaw approach.

Research Objectives

The following objectives guided the study:

1. To determine the effects of Jigsaw instructional strategy on JSS students' performance in Plane-shapes in Zuru metropolis, Kebbi State, Nigeria.
2. To determine the difference in performance between male and female students taught Plane-shapes using jigsaw instructional strategy

Research question

Two research questions were asked to direct and sharpen the focus this study, they include:

1. How does the use of Jigsaw instructional strategy influence students' performance in Plane shapes in junior secondary schools in Zuru metropolis, Kebbi State, Nigeria?
2. What is the difference in performance between male and female students taught Plane-shapes using Jigsaw instructional strategy?

Research Hypotheses

The null hypotheses were formulated to guide the study:

- HO₁:** There is no significant difference between the performance of students taught Plane-shapes using the jigsaw instructional strategy and those taught using conventional method.
- HO₂:** There is no significant difference between the performance of male and female students taught Plane-shapes using Jigsaw instructional strategy.

Literature Review

In line with the works of Yoo and Son (2015), the Jigsaw teaching strategy seeks to influence mathematics classroom in the following manner: Offer a substitute for reading and lectures as means of introducing new material, Improve the sense of mutuality and interdependence among the members, make students responsible for obtaining, rehearsing and processing own and others learning, Demonstrate an example of high-performing teamwork. The Jigsaw strategy consists of the following basic steps (Weidman & Bishop 2009): Each student in a "home" group receives a subtopic to become an expert on, Subtopic experts from each "home" group meet in an "expert" group to learn and master their subtopics, Experts return to their home group to teach their subtopic to the other members, each student undergoes individual assessments on all subtopics.

The major task of the teacher in implementing the Jigsaw strategy includes (Dhull & Verma, 2019): Carefully select and organize the material to be studied (simple, clear, and precise), Setting up the groups (heterogeneous), Providing a clear cooperative context (outline classroom activities), Supervise to ensure high-quality learning and group workings (monitor students' use of the strategy), Attending to the student's needs (learning gaps). Yoo and Son (2015) opines that students are expected to cooperate to accomplish the following: Learn and become an expert on the material via active reading and consultative review of each expert material, make a plan for teaching the material to the home group members. Creatively elaborate, integrate and individually rehearse the material to be presented, make sure every member is proficient in your material and learn that of all others assigned to your home group. According to Sahin (2011), Jigsaw strategies have the same stages, the distinction is in practices that emerged from making some useful modifications to the original Jigsaw



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application process. Today's teachers employ any of the distinct, yet related types of Jigsaw strategies in their classes depending on the set of goals they intend to accomplish.

1. Jigsaw practice developed by Aronson in 1978 was realized by forming two small groups the "home group" and "expert group", wherein students from the same "home group" break off to join their peers from other "home groups" who were given the same material in a new group called the "expert group" to collectively learn and master the material and then return to their respective "home groups" to teach it.
2. Jigsaw II developed by Slavin (1986) adds an element of competition among groups to the Jigsaw procedures to strengthen group members' commitment to helping one another in learning the content thoroughly.
3. Jigsaw III developed by Stahl (1994) expands on Jigsaw II by including a cooperative test review of the original Jigsaw procedures in an effort by teachers to assist students with concepts that appears unclear to them.
4. Jigsaw IV developed by Holliday (2002) builds on Jigsaw III by adding an introduction to the lesson, quizzes during the process to identify areas that need further explanation, and supplementary instruction to address such areas.
5. The Reverse Jigsaw developed by Hedeem (2003) is quite similar to the original Jigsaw since it utilizes and relies on small-group guided discussions with each student being responsible for learning and teaching the material. Reverse Jigsaw differs through a highly participatory structure, before joining peers in the expert group to share the highlight of common and divergent themes, each student leads the discussion of the assigned material in his home group, and then the expert group selects a reporter who will deliver the expert material to the entire class (Hedeem, 2003).
6. Subject Jigsaw developed by Doymus (2007) employs a different framework. Cooperative groups first learn and master a given subtopic together before being merged with a group(s) working on another subtopic to exchange subtopic highlights, and then group(s) of students in the merged subtopics are relocated to run new subgroups and work on other subtopics once more as a unit (Doymus, 2022).

Some benefits of the Jigsaw strategy, according to Aronson & Patnoe (2011), are: Fuels positive educational outcomes, help students improve their social skills, Boost students' self-esteem, confidence, and interest in learning, make students responsible for the teaching and learning of their peers, allow teachers to be facilitators or directors in the classroom. Every approach to teaching and learning has benefits and drawbacks, but Jigsaw has more advantages than disadvantages. Some disadvantages include: The Jigsaw strategy is a time-consuming classroom activity, The absence of one or more students has an impact on the entire class, Teachers' movement from one group to another to observe the process might be unbearable.

Exemplary Implementation of Jigsaw Instructional Strategy

Environment: Conducive environment in which students may converse in small groups face-to-face e.g. cafeterias, seminar rooms, or any other conducive space as classrooms with immovable desks don't accommodate small face-to-face group discussions (Hedeem, 2003).

Class size: Minimum and maximum limits and the ability to divide the class by the number of subtopics. For an effective exercise, at least a minimum of three groups comprising three students each, to address three subtopics (3x3x3) and one (Hedeem, 2003). Two parallel but separate Jigsaw processes can be run for large classes to avoid unwieldy exercise (Gonzalez, 2015).

Table 1: Class Description



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Topic:	Plane Shapes
Number of Students:	32
Class Level:	JSS1
Application Time:	4 weeks

i. **Determination of Subtopics:** Topics are divided into subtopics as the number of students in each small group (Doymus, 2022).

Table 2: Determination of Subtopics

Circles
Triangles
Quadrilaterals
Regular/Irregular shapes

ii. **Grouping:** The teacher creates heterogeneous groups with a certain degree of flexibility taking into account the class size and diversity in gender, ethnicity, and student level of knowledge through past exams or assessments. Two or three groups can take an additional member in classes with an uneven number of students or a habitual absentee. (Holliday, 2002; Gonzalez, 2015; Seyhan, 2021; Doymus, 2022).

Table 3: Creation of Home Groups

Jigsaw Class One	Jigsaw Class Two
Group 1 (A1, B1, C1, D1)	Group 1 (P1, Q1, R1, S1)
Group 2 (A2, B2, C2, D2)	Group 2 (P2, Q2, R2, S2)
Group 3 (A3, B3, C3, D3)	Group 3 (P3, Q3, R3, S3)
Group 4 (A4, B4, C4, D4)	Group 4 (P4, Q4, R4, S4)

iii. **Guidelines:** The teacher should provide clear instructions to students about what to do and the working process or functions of the groups. (Dhull & Verma, 2019; Doymus, 2022).

Table 4: Group Workings

Expert Group	Home Group
Learn about and become expert on the material.	Teaching area of expertise to other group members.
Plan and practice how to teach the material to Home Group members.	Learning all the materials being taught by other group members.

iv. **Roles:** The teacher assigns each student in a small group, a role to be played on a rotation basis. Each group determines the leader to manage the task, the server to record the group's work, the printer to compile the needed material and the speaker to present the group's work. Other roles could be Devil's advocate, encourager, etc. (Holliday, 2002; Doymus, 2022).

Table 5: Expert Group Roles

Jigsaw Class One	Jigsaw Class Two
A (Leader)	P (Leader)
B (Server)	Q (Server)
C (Printer)	R (Printer)
D (Presenter)	S (Presenter)

v. **Time:** Determine equal time checks on tasks, to help keep groups on the same pace and allow for a clean transition between steps throughout the Jigsaw activity (Holliday, 2002; Hedeem, 2003).



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Table 6: Implementation Plan

Week One	Week Two	Week Three	Week Four
Determination of subtopic	Experts come up with a comprehensive material to master.	Experts return to home groups to teach their materials.	Experts learn all materials taught by others members.
Experts study their unique subtopic	Experts rehearse how to teach the material.	Experts take turns teaching their assigned material.	Students undergo assessment on all subtopics.

vi. **Expert Sheet:** Expert sheet is simply a direction sheet or time saving tool to help students answer and gather information about a particular subject. The sheet should be simple, unambiguous, straight forward and accessible, such that can easily be broken into smaller chunks, and has a unifying theme that can be used to combine the smaller chunks Yoo and Son (2015).

Table 7: Expert sheet

1.	What is a (circle, triangle, and quadrilateral, regular and irregular shapes)?
2.	Identify the properties of a (circle, triangle, quadrilateral, regular and irregular shapes)
3.	Determine the perimeter of a (circle, triangle, quadrilateral, irregular shapes)
4.	Determine the area of a (circle, triangle, quadrilateral, irregular shapes)

vii. **Assessment:** The assessment takes the form of self-evaluation and peer evaluation to ensure everyone's active participation in the expert and home group activities whilst the teacher prepares quizzes and tests to record the student's individual and group performance using items aligned (not the same) with those on the expert sheet (Holliday, 2002; Dhull & Verma, 2019).

Table 8: Assessment

1.	Define a (circle, triangle, and quadrilateral, regular and irregular shapes)?
2.	Differentiate the properties/types of a (circle, triangle, quadrilateral, and irregular shapes)
3.	With the aid of a diagram, determine the perimeter of a (regular and irregular shapes)
4.	With the aid of a diagram, determine the area of a (regular and irregular shapes)

Methodology

The study adopted Pretest-Posttest quasi-experimental research design which afforded the researcher the opportunity to collect relevant data and facilitate better evaluation of the problem under study. The pretest was administered before treatment to determine the homogeneity of the two groups and the posttest was administered after treatment to determine the students' performance. The population of the study comprises of all JSS II students in the 13 public secondary schools within Zuru metropolis, with a total of 1757 students. A purposive sampling technique was employed for safety reasons to select two mixed gender schools: Government Day Secondary School (GDSS) Tudun Wada and Bahago Gomo Day Secondary School from the population, making the sample size 107 in Kebbi State, Nigeria. The sample for the study constitutes 128 students (64 male and 64 female) randomly drawn from two public secondary schools ensuring equal gender access. Twenty (25) standardized questions in multiple choice tagged "Plane-shapes Performance Test (PPT)" ($r = 0.73$) were considered for the study. The treatment covers a period of six (6) weeks. The data collected were analyzed used descriptive to answer the research question and t-test statistics at 0.05 alpha level to test the null hypotheses (All analysis is done using SPSS).

Presentation of Results

Research Question 1: How does the use of Jigsaw instructional strategy influence students' performance in Plane shapes in junior secondary schools in Birnin Kebbi, Nigeria?



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Table 9: Mean and Standard Deviation for Performance of Students in Experimental and Control Groups

Groups	N	Mean	S. D	M D
Experimental	64	80.53	2.73	
Control	64	61.39	2.28	19.14

The result in Table 9 above shows a substantial performance gap between the two groups. The experimental group being the group taught using Jigsaw instructional strategy scored 80.53 and 2.73 mean and standard deviation respectively while that of the control group pulls 61.39 and 2.28 respectively, with the mean difference of 19.14 respectively. This result revealed that students in the experimental group scored higher than their peers in the control group.

Research Question 2: What is the difference in performance between male and female students taught Plane-shapes using Jigsaw instructional strategy?

Table 10: Mean and Standard Deviation of Male and Female Students in the Experimental Group

Gender	N	Mean	S. D	M D
Experimental	32	80.34	2.78	
Control	32	80.72	2.71	- 0.38

The result in Table 10 above shows a slight difference in performance between the male and female students scores in favor of the female students. As the male students scored 80.34 mean score and 2.78 Standard deviation while the female students scored 80.72 mean scores and 2.71 standard deviation, with the mean difference of - 0.38 respectively.

HO₁: There is no significant difference between the performance of students taught Plane-shapes using the jigsaw instructional strategy and those taught using conventional method.

Table 11: Summary of Independent sample t-test for Experimental and Control Groups

Groups	N	Df	Mean	S. D	T-value	P-value
Experimental	64	126	80.34	2.78	43.5	0.0000
Control	64		80.72	2.71		

Table 11 above shows the t-test of the mean scores of experimental and control groups. The table indicate significant difference in performance between the two groups since p is less than 0.05, therefore, the hypothesis is rejected. This implies that the Jigsaw instructional strategy had a significant positive effect on student's performance in Plane-shapes compared to conventional teaching methods.

HO₂: There is no significant difference between the performance of male and female students taught Plane-shapes using Jigsaw instructional strategy.

Table 12: Summary of Independent sample t-test for male and female students in experimental Groups

Gender	N	Df	Mean	S. D	T-value	P-value
Male	32	62	80.34	2.78	- 0.5461	0.5869
Female	32		80.72	2.71		

From table 12 above, the p-value (0.5869) is greater than 0.05, indicating that there is no significant difference in the mean scores between male and female students in the experimental group. Therefore, the hypothesis if accepted, which suggest that the Jigsaw instructional strategy was equally effective for both genders. This showed that gender did not influence performance outcomes under the Jigsaw method.



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Discussion of Findings

The main objective of this study is to determine the effects of Jigsaw instructional strategy on JSS students' performance in Plane-shapes and the findings from the t-test provide compelling evidence on the effectiveness and inclusivity of the Jigsaw instructional strategy in teaching Plane-shapes to Junior Secondary Schools students. The findings of this study strongly support Anadauka, Olaoye, & Sunday (2018); Yemi, Azid, & Ali (2018); and Okafor & Nwosu (2023) study, confirming that the Jigsaw teaching strategy significantly enhances mathematics achievement among secondary school students in Abuja. The study is also in line with Areelu & Ladele (2018) study which shows that the Jigsaw instructional strategy significantly improves students' interest and engagement in mathematics with no gender bias among secondary school students in Lagos. The study is also in support of Anadauka, Olaoye, & Sunday (2021) study that found no significant gender difference in mathematics achievement among students taught using Jigsaw strategy.

Conclusion

The findings reveals that the Jigsaw instructional strategy significantly enhances students' academic performance in Plane-shapes compared to conventional teaching methods, affirming the effectiveness of the Jigsaw approach in promoting deeper understanding and active engagement in mathematics classroom. In addition, the absence of a significant difference in students' performance across gender suggest that Jigsaw strategy is equitably and inclusively gender friendly.

This study also exemplifies Jigsaw teaching strategy as cooperative learning strategy capable of transforming mathematics classrooms from a place of passive reception of knowledge into a dynamic active learning abode where students take complete ownership of their learning moving equitably between being learners to becoming teachers, in an attempt to deepen their mathematics process and conceptual understanding, while developing communication and collaborative skills essential for lifelong learning. The Jigsaw teaching strategy serves as an effective and scalable model for improving not only students' performance in mathematics among secondary school students but also is efficient for strengthening and deepening students conceptual understanding, communication, and cooperative skills in mathematics and other related disciplines. Furthermore, the study produced a coherent framework that shifts classroom dynamics from teacher-centered to student-driven ensuring each and every student active participation as they struggle to prove their worth to their peers.

Recommendations

The following recommendations were made based on the findings from this study:

1. Jigsaw instructional strategy should be used in teaching and learning of mathematics since this method is proved effective in enhancing students' academic performance compares to the conventional methods.
2. Mathematics teachers should be patient while using this strategy in order to obtain better results since it is time consuming.
3. Creation of Mathematics laboratories should be emphasized in all secondary schools for effective students' engagement.



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MINERS ADAPTATION STRATEGIES ON IMPACT OF ARTISANAL MINING ACTIVITIES AMONG RURAL COMMUNITIES IN KADUNA STATE, NIGERIA

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Abstract

Mining serves as a major source of livelihood for many rural communities around the world. However, it often exposes miners to various risks, including workplace accidents, consumption of contaminated food and water, and the spread of diseases. This study explores how miners in the rural areas of Kaduna State, Nigeria, adapt to the challenges associated with artisanal mining. Data were gathered using focus group discussions, in-depth interviews, and direct observations in the field. The findings, analysed using descriptive statistics with NVivo Version 11.0, reveal a variety of coping strategies employed by miners. These include avoiding polluted water sources, treating water through boiling, filtration, or chemical methods, relying on family, unions, and friends for medical support, and adopting safety measures like wearing protective gear and ensuring safe mining practices. Other strategies include consuming treated or packaged water, promoting awareness about mining hazards, and improving personal nutrition. Based on these findings, the study recommends that miners actively engage with their unions and build strong relationships with peers and community members to ensure support during times of need. Secondly, miners should ensure safe mining practices by avoiding underground mining and mishandling of mining equipment.

Keywords: Artisanal Mining, Miners, Adaptation Strategies, Livelihood and Rural Communities

Introduction

Artisanal mining remains a pervasive livelihood source across many developing regions. Income generation is the main reason responsible for involvement in artisanal mining (Traore *et al.*, 2024). The sector presents both opportunities and challenges providing income while exposing communities to environmental degradation, health risks, and social instability (Mutagwaba *et al.*, 2018; Oruonye *et al.*, 2024; Fagariba *et al.*, 2024; Donkor *et al.*, 2024). Despite these challenges, miners have developed diverse adaptation strategies to mitigate adverse effects of mining. Globally, adaptation strategies by artisanal mining communities include resilient responses such as land reclamation, alternative potable water sources, and protective health measures like mosquito nets and covering mining pits demonstrating a pattern of coping, despite hazardous conditions (Mabe *et al.*, 2021). In Sub-Saharan Africa, artisanal mining contributes to household livelihood by providing employment and income. For instance, it constitutes a critical livelihood in Uganda, engaging an estimated 200,000 miners and supplying about 30 % of the country's gold exports (Intergovernmental Forum-IGF, 2021). Miners lack basic safety equipment and using hazardous processes like mercury amalgamation during mining processes (Awori & Afedraru, 2024). This informality exacerbates environmental degradation, occupational risks, and public health threats (Twinobusingye, 2021)

In Ghana, displaced artisanal miners responded to the sector bans by turning to alternative livelihoods such as farming, trading, and labour work, with farming emerging as the most common coping strategies (Mabe *et al.*, 2021). On a broader scale, innovations replacing harmful practices such as mercury use are gaining traction. In Ethiopia, for example, gravity separation technology and mobile on-site processing units have started replacing toxic extraction methods, reducing environmental pollution and enhancing extraction safety (Teku, 2025). Miners and communities



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demonstrate resilience by engaging in livelihood diversification such as, small trade or alternative income sources especially in response to shocks (Mukooli, 2022). Common responses on injuries sustained during mining include self-medication, involving the use of traditional remedies, such as applying locally made balms for physical injuries (Wireko-Gyebi *et al.*, 2022).

In Nigeria, although regulations like the Nigerian Minerals and Mining Act (2007) and environmental enforcement by NESREA exist, artisanal mining communities often lack awareness about these frameworks and appropriate safety or environmental practices. This regulatory gap hinders effective adaptation among miners (Oruonye *et al.*, 2024). For instance, in Ebonyi State there was low safety awareness among miners, with most failing to comply with environmental and safety regulations (Oruonye *et al.*, 2016). Kaduna State possesses a rich abundance of commercially valuable mineral resources, such as tin, tantalite, sapphire, zircon, gold, and nickel that attract mining. The environmental impacts of artisanal mining in Kaduna are significant. The mostly unregulated practice of artisanal mining has resulted in environmental degradation, land displacement, and the disruption of traditional livelihoods like farming and livestock rearing. These effects are especially troubling for rural communities that depend heavily on natural resources for daily sustenance and economic stability (Kareem & Owao, 2000; Adekoya, 2003; Yunana & Banta, 2014; Gadzama, 2015). for example, a 2025 study revealed severe degradation of vegetation, farmlands, biodiversity, grazing lands, and domestic water sources, undermining local resource sustainability (Zankan *et al.*, 2025).

Within mining communities, participation in artisanal mining often spans entire households and generations, with children routinely integrated into mining labour from a young age, reshaping familial norms and livelihoods away from farming (Gadzama, 2020). In many instances, mining has reduced access to arable land, contaminated water sources, and led to injuries and fatalities among miners. In light of these escalating challenges, it is crucial to assess miners' adaptation strategies for coping with the impacts of artisanal mining in Kaduna State, Nigeria. Such research is vital for shaping informed policies that safeguard rural livelihoods while supporting sustainable resource management and fostering economic development.

Materials and Methods

Study Area

Kaduna State is situated in North Central Nigeria and is one of the country's 36 states. It spans latitudes 9° 03'N to 11° 32'N and longitudes 6° 05'E to 8° 38'E, east of the Greenwich Meridian. Covering 46,053 km² about 5% of Nigeria's total land area it shares borders with Kano, Katsina, and Zamfara States to the north; Bauchi and Plateau States to the east; Niger State to the west; and the Federal Capital Territory and Nasarawa State to the south. Politically, Kaduna State is divided into 23 local government areas (see Figure 1).

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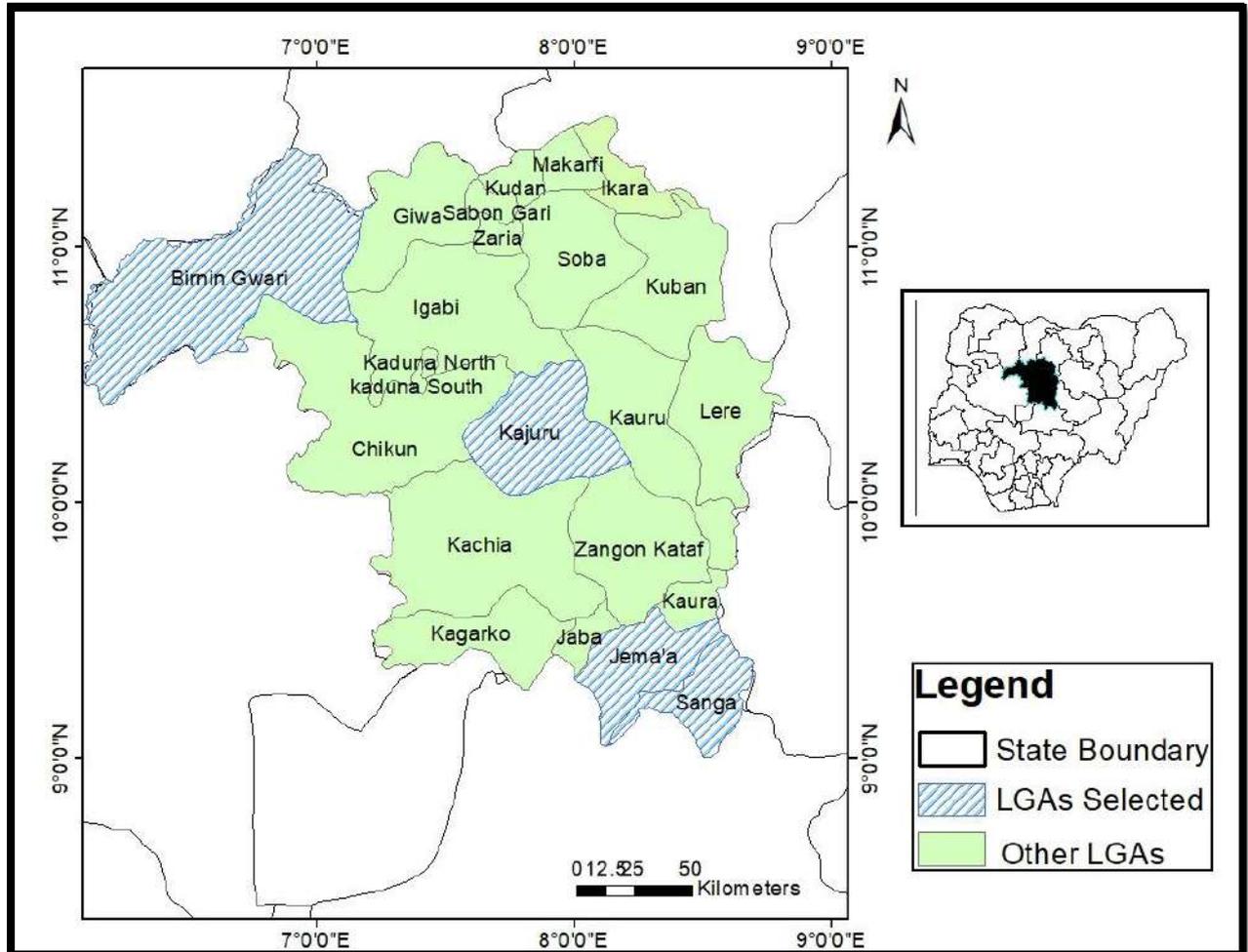


Figure 1: Map of Kaduna State showing the local government Areas selected for the study

Source: GIS Lab, Department of Geography BUK

Kaduna State has an AW climate type (Koppen classification) with two distinct seasons: dry and wet. The southern part, around Kafanchan and Kagoro, experiences a longer rainy season from April to October, while the northern areas like Zaria and Makarfi have a shorter rainy season from mid-May to September, similar to Kano (Abaje *et al.*, 2018). Rainfall peaks once annually, usually in August or September, influenced by tropical maritime and continental air masses. Annual rainfall decreases from about 1659 mm in the south (Kafanchan) to 1246 mm in the central area (Kaduna) and 1017 mm in the north (Zaria). The state’s average annual rainfall and humidity are 1307 mm and 56.6%, respectively, with temperatures ranging from 15.1°C to 35.2°C. Orographic effects from the Jos Plateau and Kagoro hills positively influence the southern climate, affecting rainfall, temperature, and humidity (Ishaya and Abaje, 2008). The study area is located in Nigeria’s Guinea Savanna region, which receives substantial rainfall and experiences limited bush burning (Buba, 2015). It is underlain by Pre-Cambrian basement complex rocks mainly granite, gneiss, migmatite, and quartzite favorable for mineral mining (NMMS, 2017). Key economic activities include farming, mining, commerce, animal rearing, and hunting. The population is culturally diverse, with the north largely inhabited by Hausa Muslims, while the south is home to various ethnic groups, predominantly Christians, each with distinct traditions, ethnic identities, and social norms.



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Data Collection

Data for this study were gathered through Focus Group Discussions (FGDs), in-depth interviews, and direct field observation. Artisanal miners were purposively selected, as they are directly involved in mining and best positioned to share insights on the adaptation strategies they use. Only individuals aged 18 and above were included, as they are capable of independent decision-making. Four local government areas - Sanga, Jema'a, Kajuru, and Birnin Gwari were purposively chosen due to active artisanal mining activities. In each LGA, one FGD was conducted with a group of 6-10 miners, facilitated by a moderator and supported by a note-taker who also handled audio recordings. Participants were selected from the mining population in each area. Additionally, four individuals, including mining officials, were selected for in-depth interviews across the study locations. These interviews focused on key issues relevant to the research objectives. Direct field observations were also conducted to examine mining processes, identify minerals extracted, and document adaptation strategies used by miners.

Data Analysis

The data for this study were analyzed using descriptive statistics with the aid of NVivo Version 11.0, a software designed for qualitative and mixed-methods research. NVivo is capable of processing unstructured data such as text, audio, video, and images. It allows researchers to efficiently manage and condense large volumes of qualitative information from interviews, FGDs, in-depth interviews, and participatory rural appraisals into organized textual formats. The software supports transcription and coding, enabling the categorization of participants' opinions and perceptions into concise themes. The results were presented in tabular form for clarity.

Presentation of Results and Discussion

Miners Adaptation Strategies to cope with the effect of Artisanal Mining in the Study area

Table 1 presents the adaptation strategies employed by miners to cope with the impacts of artisanal mining in rural communities of Kaduna State, Nigeria. The findings reveal that miners adopt various coping mechanisms, including the use of protective gear such as nose masks, rain boots, and gloves; avoiding underground mining during the rainy season; relying on family support; and investing in asset acquisition for future security.

Table 1: **Miners Adaptation Strategies on impact of Artisanal Mining activities**

Strategies to cope with injuries sustained during mining	Strategies to maintain good health during mining	Strategies to cope with the effect of rainy season on mining
<ul style="list-style-type: none">i. Support from union members and friends to treat the victims,ii. Support from the victim's family and Acquisition of assets	<ul style="list-style-type: none">i. Drinking of sachet/ treated water,ii. Sensitisation campaign on the dangers of mining,iii. Sleeping under mosquito net and utilisation of blanket,iv. Utilisation of nose mask,v. Utilisation of rain boot and gloves,vi. Proper handling of mining equipment,vii. Eating balance diet, andviii. provision of pillars underground during mining	<ul style="list-style-type: none">i. Avoiding underground Mining andii. Utilisation of water pumping machine



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Strategies to Cope with Injuries Sustained during Mining activities in Kaduna State

Miners often suffer various injuries during mineral extraction, either due to ground subsidence or from the use of mining tools and equipment. To cope with such injuries, they adopt several strategies, including receiving assistance from union members and friends for medical treatment, relying on family support, and investing in asset acquisition as a form of financial security.

Support from Union and Friends to Treat the Victims

Some participants noted that union members who sustain injuries during mining activities receive financial support for medical treatment provided they have fulfilled their required contributions to the union. Those who fail to pay their dues are not recognised as union members and, therefore, are not eligible for such support. Another key responsibility of the union is to assist in rescuing individuals trapped underground due to subsidence. However, financial aid is not extended to non-contributing individuals, regardless of the severity of their injuries, as their lack of participation reflects a lack of unity. For union members who die as a result of mining accidents or illness, the union prioritises funeral arrangements, including grave digging and providing a casket. Additionally, friends of the affected individuals often contribute funds to support their treatment. This collective support system is one of the reasons miners tend to work in groups when extracting minerals. This perception was well illustrated by a discussant:

“We support injured members, rescue the trapped, and bury the dead but non-contributors receive no help, regardless of injury”.

Support from the Victim's Family

Some participants noted that victims' families play a crucial role in supporting injured relatives, often covering hospital bills themselves. In many cases, this financial burden forces them to sell personal assets like land and livestock. Families, especially immediate relatives, go to great lengths to ensure the recovery of their loved ones. This finding aligns with Arthur-Holmes et al. (2016), who observed that families of artisanal mining victims often sacrifice their resources for treatment. A notable example is the case of a miner from Bayya Gidan Waya who suffered a spinal cord injury due to subsidence. His family reportedly spent over ₦800,000 on his treatment, with both nuclear and extended members contributing. To raise the funds, they were compelled to sell valuable assets, reflecting the severe economic strain such injuries place on families involved in artisanal mining.

Acquisition of Assets/Investment

Participants noted that they invest earnings from artisanal mining in assets as a strategy to cope with potential injuries or death. Some purchase houses to rent out, while others buy motorcycles or vehicles for commercial use. These assets serve as alternative income sources, especially when miners are injured, lose body parts, or grow too old to work. By using their income wisely, they create financial security for themselves and their families in case of accidents or future incapacity caused by the physically demanding and risky nature of artisanal mining. Some miners invest in small businesses, such as provision stores, while others save part of their income in banks for emergencies or future needs. These strategies help them cope with injuries, disability, or even death, as families can rely on the assets left behind. This aligns with Wireko-Gyebi et al. (2022), who reported that miners use savings and investments to manage mining-related risks. Similarly, UNDP. (2009) and Bargarioria et al. (2020) found that miners turn to alternative livelihoods like commercial transport, woodfuel collection, and charcoal production when mining activities stop or become unsustainable.

Strategies to Maintain Good Health during Mining in Kaduna State

Miners in rural Kaduna State adopt various strategies to protect their health during mineral extraction. These include drinking treated or sachet water, attending sensitization campaigns on mining hazards, using mosquito nets and blankets, wearing nose masks, rain boots, and gloves,



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handling equipment properly, eating balanced diets, and providing support pillars underground for safety. These coping measures help reduce health risks and improve resilience in hazardous mining environments.

Drinking of Sachet or Treated Water

Most participants reported using sachet water during mineral extraction to maintain good health and avoid polluted river water. However, they acknowledged that some sachet water is illegally produced and may not be safe. Due to high demand at mining sites, vendors often raise prices. This aligns with Makwerere et al. (2018), who noted that households buy water during extreme situations. In remote or rocky mining areas, limited access to food and water vendors forces miners to drink contaminated water, increasing the risk of diseases like typhoid and cholera, which negatively affects their health and overall well-being. Some FGD participants said they drink treated water, often boiling it at home before bringing it to mining sites. This practice, mainly adopted by new miners, helps avoid relying on polluted river water. They usually heat the water at night to kill germs and let it cool for the next day's use. Occasionally, they add alum to purify it further. These efforts help them maintain good health during mining. However, when they earn money from mineral sales, they often switch to buying sachet water instead of using their treated water.

Sensitisation Campaign on the Dangers of Mining

Some participants noted that miners are regularly sensitised to the health risks of mineral extraction. Health personnel are invited to mining sites to educate miners and those indirectly involved like food and water vendors on the dangers of environmental pollution, poor hygiene, and exposure to harmful chemicals like mercury. They advise vendors to keep food covered to prevent contamination and encourage miners to avoid drinking polluted water, use mosquito nets, and wear protective gear such as rain boots, gloves, and nose masks. While some miners follow these health guidelines, others choose not to adopt the recommended safety practices. A leader from one of the mining sites in the study area shared the following insight: "As leaders, we ensure members stay healthy so they can work effectively, earn income, and pay union dues. We regularly invite health personnel to advise miners on health issues during mining activities"

The findings of this study contrast with those of Charles et al. (2013), who reported that despite the rise in artisanal mining in Tanzania, there is a significant lack of community-based and occupational health education programs addressing the hazards of dangerous chemicals like mercury exposure.

Sleeping under Mosquito Net and utilisation of Blanket

Mining areas often have pits and ponds that serve as breeding grounds for mosquitoes and other disease vectors. Many participants said they sleep under mosquito nets to prevent malaria, developing this habit to reduce infection risk. Some also cover themselves with blankets to protect against cold and illnesses like pneumonia. The use of insecticide-treated nets and indoor spraying has helped reduce malaria cases in Sub-Saharan Africa (Tizifa et al., 2018). Those who contract malaria seek treatment to recover. However, many miners avoid using nets during the hot dry season because nets trap heat and limit airflow, making sleep uncomfortable. This reduces their consistent use of mosquito nets despite the health benefits. This was clearly illustrated by one of the participants, who shared: "I sleep under a mosquito net and use a blanket to avoid malaria and cold-related illnesses. However, some miners avoid nets due to heat, increasing their risk of malaria"

This aligns with findings by Gatune and Besada (2020) and Adum et al. (2023), who reported that gold miners account for most malaria infections due to their failure to follow recommended prevention measures.



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Utilisation of Nose Mask, Rain Boot and Gloves

Participants noted that wearing nose masks is one strategy used to prevent respiratory diseases during mining. Masks help reduce inhalation of dust and limit the spread of illnesses like COVID-19 and Ebola, while also lowering the risk of asthma and pneumonia. Many miners see masks as effective protection and use them during mineral extraction. This aligns with Brooks and Butler (2021), who found that community mask use significantly reduces the transmission of respiratory diseases. However, some miners reject masks, believing they restrict oxygen intake especially during underground mining where air is limited. Others simply disregard health advice and refuse to wear masks, doubting their effectiveness. This attitude, rooted in disbelief or indifference, leads to poor adherence to preventive measures despite the known risks.

Some FGD participants noted that they use rain boots and gloves during mining to prevent injuries. These protective tools are especially common among miners working in rocky or hilly areas, where movement is difficult. Rain boots help them navigate rough terrain and carry materials to streams for washing, while gloves protect their hands when handling tools like diggers, shovels, hammers, and chisels. However, many miners still neglect these safety measures, believing boots do not guarantee protection, as injuries and even deaths have occurred despite using them. Those who avoid protective gear are often the ones who experience frequent and serious injuries during mineral extraction. This is what one of the participants has to say: "Rain boots and gloves are essential for mining, especially on rocky surfaces. Boots protect us from sharp rocks, while gloves help safely handle mining tools" This study aligns with the findings of Nakua et al. (2019) and Gatune and Besada (2020), who reported that a moderate number of miners choose to use protective measures such as rain boots and hand gloves while working.

Proper Handling of Mining Equipment

Improper handling of mining equipment poses serious health risks to miners, often leading to injuries during mineral extraction. Some participants emphasized the importance of carefully using tools like diggers, shovels, hammers, and chisels to avoid accidents. However, not all miners follow this practice, resulting in varying degrees of injuries. Nakua et al. (2019) also observed that injuries often result from both equipment misuse and slippery terrain. Additionally, mining tools are sometimes used as weapons during conflicts between miners, leading to severe harm or even death. In response, some mining communities have introduced strict rules, including penalties or reporting offenders to security agencies. Miners found using tools to fight may be banned from mining in that area. These measures have helped reduce violence and injuries in several mining communities in Kaduna State, promoting safer mining practices among workers.

Eating of Balanced Diet

Mining requires intense physical effort, prompting miners to consume energy-rich foods, especially carbohydrates, to maintain strength. Some participants noted that they eat balanced meals using their earnings from artisanal mining to stay healthy and energised. This supports Sarwar et al. (2015), who stated that choosing nutritious foods promotes a healthy body, improves mood, and reduces disease risk. However, despite awareness of healthy eating, some miners engage in harmful habits like consuming alcohol, hard drugs, and tobacco, which negatively affect their health and behavior in host communities. These habits also prevent them from saving money, pushing their families toward poverty. Many miners eat whatever food is readily available, regardless of its nutritional value, simply to feel full. This inconsistent diet, combined with substance abuse, contributes to poor long-term health and unstable financial situations for both the miners and their households. The lack of proper nutrition and financial planning reflects broader challenges faced by



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artisanal miners in maintaining sustainable livelihoods. Access to a better and more varied diet helps address issues related to macronutrient and micronutrient deficiencies, as well as malnutrition or hidden hunger. Singh (2023) emphasizes that the human body requires safe, sustainable, and balanced diets to bridge the gap between nutrient needs and actual intake, thereby correcting undernutrition, overnutrition, and micronutrient deficiencies.

Provision of underground pillars during mining

Most of the participants noted that those who go for underground mining make sure they provide underground pillars to avoid subsidence. Pillars serve as standing walls that prevent the collapse of underground roofs. This enabled them to mine the minerals underground to generate income for their families. But there are some instances where miners do remove some of the pillars that hold the roofs as a result of presence of minerals in the standing walls. This has led to collapse of underground walls in different mining communities of Kaduna State. Example of this are the cases of subsidence that occurred at Ungwan Magaji (Mbututu), Godo Godo and Hayin Gada Gidan Waya all of Jema'a local government that led to burial of miners underground. This is what one of the participants has to say: "During underground mining, we make sure we provide pillars to hold the roof in order to prevent it from collapsing. But at times when miners discover that those standing walls/pillars have minerals, they chop them which always lead to collapse of roofs underground and as a result causing death to miners. Just look what happened at Ungwan Magaji, Godogodo and Hayin Gada Gidan Waya recently. People killed themselves just because of minerals. That is what I tried to avoid".

Strategies to Cope with the Effect of Rainy Season on Mining in Kaduna State

The study participants also noted that miners prevent underground mining and utilising pumping machine or submersible pump to cope with the effect of rainy season on mining activity.

Avoiding Underground Mining

Some participants explained that to cope with the rainy season's impact, miners often avoid underground mining known to cause subsidence and instead adopt surface mining. Rainfall softens and lubricates the soil, increasing the risk of roof collapse in underground pits. To reduce the danger, many miners steer clear of such practices during this period. This aligns with earlier findings (Abubakar, 2019) indicating that excess moisture weakens foundations. However, not all miners see it as a threat, and some continue underground mining despite the risks. For instance, in May 2022, several miners were buried in a collapsed underground pit at Ungwar Magaji in Jema'a Local Government due to subsidence during the rains. Many miners in the study area adopt surface mining during the rainy season due to its lower risk of injury or death. Having abandoned agriculture, they rely on mining as a full-time livelihood. To cope with seasonal hazards, they avoid underground mining despite its richer mineral deposits to reduce the risk of subsidence and accidents caused by rain-softened soil. This shift to surface mining allows continued extraction while minimizing the dangers associated with underground operations during the rainy season.

Utilisation of pumping Machine

The study revealed that miners in some communities of Kaduna State utilise pumping machines and submersible pumps to remove water from mining pits and wells, particularly during the rainy season, in order to create space for mineral extraction. This water removal technique is a common adaptation strategy that enables continued mining operations despite heavy rainfall. However, in areas with high water saturation, pits tend to refill quickly even after water has been pumped out. This persistent water accumulation often forces miners to abandon such sites to avoid the risk of pit wall collapse, which can result in serious injuries or fatalities. The rainy season poses a significant challenge to mining activities, as the accumulation of water in pits hinders access to mineral



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deposits. One participant noted that: “We use pumping machines to remove water from pits, but in some areas, water quickly refills due to rising water tables, especially in rainy seasons, making mining impossible. We often abandon such sites to prevent accidents. However, with the help of pumping machine or submersible, water is removed from these pits allowing miners to allow the miners continue with their activities, though subsidence occurs especially when soils have absorbed too much water leading to killings and injuries of miners.

Conclusion

Mining impacts households in various aspects of their lives, often compelling them to seek alternative means of livelihood. This activity poses significant risks, including the loss of agricultural land, depletion of domestic water sources, destruction of vegetation, and incidents leading to injury or death. It also contributes to social challenges such as school dropouts, unintended pregnancies, and early marriages. In response, households in affected communities have adopted a range of coping strategies to manage the adverse effects of artisanal mining. These include saving money and starting businesses as financial buffers, building homes for personal use or rental income. Additional strategies involve avoiding contaminated water sources, consuming treated or packaged water, and avoiding underground mining during the rainy season. Collectively, these adaptive measures have helped many households in Kaduna State’s mining communities endure the ongoing challenges posed by artisanal mining. Based on these, the study recommends that miners actively engage with their unions and build strong relationships with peers and community members to ensure support during times of need. Ssecondly, miners should ensure safe mining practices by avoiding underground mining and mishandling of mining equipment. Additionally, both households and the government should prioritise the reclamation of degraded surface and underground mining sites for agricultural purposes, as a sustainable strategy to address the growing risk of food insecurity.

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Transforming Pedagogical Practices: The Impact of a Connected Learning for STEM Intervention on Science and Mathematics Teachers in Northern Nigeria

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Abstract

The purpose of this study is to explore the impact of the Connected Learning for Capacity Building initiative on the pedagogical practices of secondary school science and mathematics teachers in Northern Nigeria. It specifically examines how participation in the programme impacted teachers' understanding and implementation of equitable, inclusive, and learner-centered instructional strategies. The study adopted a qualitative descriptive research design. Data were collected through semi-structured interviews with a purposive sample of 20 novice teachers across three phases, namely baseline, midline, and endline. The data were analyzed thematically to trace the evolution of teachers' pedagogical conceptions and practices, particularly in relation to equity and inclusion. The findings indicate a substantial transformation in teachers' pedagogical orientations and classroom practices. Participants demonstrated an expanded understanding of equity and inclusion, moving beyond academic ability to consider gender, socioeconomic background, and geographical disparities. Furthermore, teachers increasingly applied principles of Universal Design for Learning (UDL) by integrating diverse instructional strategies such as the use of local materials, multimedia resources, and collaborative learning activities to accommodate varied learner needs and contexts. This study provides empirical insights into how a connected learning framework that incorporates Open Educational Resources (OER) and a mobile-based Community of Practice (CoP) can foster pedagogical innovation in resource-limited settings. It highlights the potential of connected learning as a sustainable model for teacher professional development and as a means to promote equitable quality education in alignment with Sustainable Development Goal 4.

Keywords: teacher professional development, connected learning, equity and inclusion, Universal Design for Learning (UDL), pedagogical content knowledge, Sub-Saharan Africa, STEM education

Introduction

The world has evolved from an industrial-based economy to a knowledge-based economy, which has impacted the process of education. Specifically, STEM education has become a cornerstone of 21st-century learning, requiring teachers to acquire advanced pedagogical and technological competencies to deliver meaningful classroom experiences. This will raise manpower that will add value to the knowledge-based economy of the 21st-century. However, many teachers in developing contexts still rely on traditional, teacher-centered practices that limit student engagement and critical thinking. The pursuit of inclusive and equitable quality education, which forms a cornerstone of the United Nations Sustainable Development Goal 4 (SDG 4), continues to pose significant challenges across the globe (United Nations, 2015). In Northern Nigeria, this challenge is intensified by constraints such as limited resources, overcrowded classrooms, and high levels of student diversity. These factors often leave teachers insufficiently prepared to address the varied learning needs within their classrooms (Yaki et al., 2019). One of the critical barriers to achieving inclusive Science, Technology, Engineering, and Mathematics (STEM) education lies in the limited capacity of teachers to design and implement instructional practices that accommodate learners with diverse academic abilities, gender identities, socioeconomic backgrounds, and geographical contexts (Nguyen et al., 2020).



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In response to these challenges, the Connected Learning for STEM (CL4STEM) project was developed as an innovative professional development initiative aimed at strengthening teachers' pedagogical content knowledge (PCK) and their capacity to promote higher-order thinking with inclusion and equity (HOTIE). The project is anchored in the theoretical principles of Universal Design for Learning (UDL), which advocates for the proactive creation of flexible and accessible learning environments that minimize barriers and respond to the diverse needs of all learners (Meyer et al., 2014). Within the CL4STEM framework, these principles are operationalized through the use of curated Open Educational Resources (OER) and a mobile-based Community of Practice (CoP). Together, these components foster a continuous, collaborative, and contextually relevant professional learning experience for teachers.

The UDL framework is structured around three central principles: providing multiple means of engagement, representation, and action and expression. These principles offer a comprehensive approach to designing inclusive and responsive classroom practices (Meyer et al., 2014). Although studies in other African contexts, such as Kenya, have highlighted the benefits of UDL in addressing learner diversity (Elder et al., 2016), limited evidence exists regarding its integration within large-scale, technology-supported professional development initiatives in West Africa. This study therefore, seeks to address this gap by exploring the impact of the CL4STEM project on the pedagogical practices of science and mathematics teachers in Northern Nigeria.

Statement of the Problem

The goal of STEM education is to make learning "real" by equipping students with essential 21st-century skills, including critical thinking, problem-solving, digital literacy, and collaboration, thereby preparing them to tackle complex, real-world challenges (Partnership for 21st Century Skills, 2019). Despite this recognized importance, a persistent gap exists between the goals of STEM education and its effective implementation in classrooms. A key barrier is the varying capacity of teachers, who may lack sufficient training, resources, and support to adopt innovative, student-centred pedagogies (Darling-Hammond et al., 2017). This is particularly acute in under-resourced settings, where teachers often face isolation and limited access to professional learning communities. The Connected Learning for Teacher Capacity Building in STEM (CL4STEM) project emerges as a direct response to this challenge. CL4STEM aims to empower high school teachers and their students through engaging, interactive, and hands-on learning experiences, fostering the knowledge, skills, and values needed for success in the 21st century. Rooted in constructivist and transformative teaching principles, which emphasize that knowledge is built through experience, critical reflection, and collaboration (Mezirow, 1991; Vygotsky, 1978)

Objectives of the Study

This study explores the following research objectives in three Northern Nigerian states:

1. To explore the impact of CL4STEM capacity-building innovation on science and mathematics teachers' practices toward equity and inclusive instruction.
2. To explore science and mathematics teachers' experiences of participating in the CL4STEM project modules and community of practice toward promoting equity and inclusive instruction.

Research Question

The following research question guides the study:

1. What is the impact of the CL4STEM capacity-building innovation on science and mathematics teachers' understanding and implementation of equitable and inclusive pedagogical practices?



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2. What are science and mathematics teachers' experiences of participating in the CL4STEM project modules toward promoting equity and inclusive instruction.

Literature Review

The importance of inclusive education is firmly established in global educational policy and research. UNESCO (2020) continues to emphasize the need for educators and policymakers to adopt inclusive instructional strategies that ensure meaningful learning opportunities for all students. Achieving this goal requires a departure from one-size-fits-all teaching approaches toward pedagogical practices that recognize and respond to learner diversity and variability (Meyer et al., 2014).

Universal Design for Learning (UDL) has emerged as a prominent framework to guide this pedagogical transformation. Drawing inspiration from the concept of universal design in architecture, UDL advocates for the intentional development of flexible learning environments that accommodate a wide range of learner needs from the outset (Meyer et al., 2014). Empirical evidence supports its effectiveness in enhancing student engagement and achievement across diverse educational settings. For example, Elder et al. (2016) reported that the implementation of UDL-based strategies in Kenyan primary schools enabled teachers to better address the varied learning needs of their students. Likewise, Yaki et al. (2019) observed that applying UDL principles within STEM instruction helped to reduce achievement disparities among students with differing academic abilities in biology classrooms.

Translating frameworks such as UDL into classroom practice, however, requires effective teacher professional development (TPD). Conventional one-off workshops have often proven insufficient in producing sustained pedagogical change (Blanton et al., 2018). Contemporary professional development models, therefore, emphasize the need for continuous support, collaboration, and contextual relevance. Communities of Practice (CoPs) provide a valuable platform for shared learning, reflection, and problem-solving among teachers, enabling them to collaboratively develop strategies for addressing learner diversity (Blanton et al., 2018). When such collaborative learning structures are integrated with accessible digital resources such as Open Educational Resources (OER) and supported through mobile technologies for scalability, as demonstrated in the CL4STEM model, they hold significant potential to transform teaching practices and advance inclusive education in resource-constrained contexts.

Research Methodology

This study adopted a qualitative research design to obtain a rich and detailed understanding of the changes in teachers' pedagogical perceptions and practices over time. A descriptive longitudinal approach was employed, with data collected through semi-structured interviews at three key stages of the intervention: baseline (pre-intervention), midline (during intervention), and endline (post-intervention). This design allowed for an in-depth exploration of how teachers' pedagogical conceptions evolved as they engaged with the connected learning initiative.

Participants and Sampling

The study was conducted across three states in Northern Nigeria, namely Niger, Kaduna, and Kano. The target population comprised secondary school science and mathematics teachers. Using purposive sampling, 20 teachers specializing in Biology, Chemistry, Physics, and Mathematics were selected from a larger intervention cohort of 80 participants. The selection criteria included: (1) being a novice teacher with limited prior professional development experience, and (2) possessing a functional Android smartphone to enable participation in the mobile-based components of the



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program. This ensured that participants were both representative of early-career teachers and equipped to engage with the digital learning environment.

The CL4STEM Intervention

The Connected Learning for STEM (CL4STEM) intervention was designed as a sustained capacity-building program aimed at enhancing teachers' pedagogical content knowledge and their ability to apply inclusive and equitable instructional practices. Participants engaged with specially curated Open Educational Resources (OER) structured around the principles of Universal Design for Learning (UDL). In addition, a mobile-based Community of Practice (CoP) was established using the Telegram application to facilitate ongoing interaction among teachers and expert educators. Through this platform, participants shared lesson plans, teaching videos, and reflective experiences, thereby promoting collaborative learning, peer support, and contextualized professional growth.

Data Collection

Qualitative data were gathered through semi-structured interviews and classroom observations conducted at the baseline, midline, and endline stages of the intervention. The interview protocols were developed based on constructs of subject matter knowledge, pedagogical content knowledge, and inclusive instructional planning. Supplementary data were obtained from teacher educators' module reports to triangulate findings. Classroom observations were conducted using a non-participant observation approach, with detailed field notes recorded throughout the process (Maxwell, 2013). Transcripts were anonymized and labeled using teacher identification codes (e.g., 3101, 3103, 3104). Observational data captured classroom dynamics, including indicators such as students' engagement in collaborative learning activities and teachers' use of inclusive instructional strategies.

Data Analysis

Thematic analysis was employed to examine the qualitative data following Braun and Clarke's (2006) six-step framework: familiarization with the data, generating initial codes, identifying themes, reviewing themes, defining and naming themes, and producing the final analysis. The data were organized around two overarching research questions, from which four major themes emerged: (1) Understanding of Equity and Inclusion, (2) Planning for Equitable and Inclusive Instruction, (3) Teacher Inclusive Practices, and (4) Teachers' Experiences and Perceived Impact. Changes in the frequency of thematic codes were tracked across phases to identify patterns of growth (for example, understanding of inclusion increased from 15% at baseline to 50% at endline based on participant responses).

Discussion

The analysis identified two central themes illustrating the transformative impact of the CL4STEM project on teachers' pedagogical approaches.

Evolving Conceptions of Equity and Inclusion

At the baseline, teachers' understanding of learner diversity was largely monolithic, centring almost exclusively on academic ability, often described in binary terms of "slow" versus "fast" learners.

- i. Baseline Exemplar:** "In the class we have students with different learning ability, we have students with slow learning ability, and students with fast learning ability" (Teacher 3101, Mathematics, Male).

Data from the midline and endline phases revealed a significant conceptual expansion. Teachers demonstrated a more nuanced understanding, identifying gender, socioeconomic status, family



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background, and geographical location (rural vs. urban) as critical dimensions of diversity that necessitate equitable pedagogical responses.

ii. Midline/Endline Exemplars:

- a. "I realized that gender is very, very important to be considered in mathematics class." (Teacher 3101, Mathematics, Male, Midline).
- b. "Some of my students are very slow... those in the rural area face more difficulty, and students with poor backgrounds also." (Teacher 3702, Biology, Female, Midline).
- c. "The principle of universal design Learning helps me to guide students with different backgrounds." (Teacher 3305, Physics, Female, Midline).

Adoption of UDL-Aligned Instructional Practices

This broadened understanding was coupled with a marked shift in pedagogical practices, reflecting the core principles of UDL.

iii. Multiple Means of Representation: Teachers reported increasingly using varied instructional materials to enhance accessibility.

- a. **Teacher 3118 (Mathematics, Female, Endline):** "For some of the students, maths is abstract and difficult, but if you use the locally available materials and video as teaching aids... they will understand it."

iv. Multiple Means of Action & Expression (Collaborative Learning): Intentional, structured group work became a dominant strategy to engage diverse learners and leverage peer-supported learning.

- a. **Teacher 3702 (Biology, Female, Midline):** "I also group them... according to their capability... so that they'll be able to blend with each other."
- b. **Teacher 3503 (Chemistry, Male, Endline):** "Grouping students helps the low learners to learn from their peers."

Table 1: Summary of Thematic Shifts in Teacher Pedagogy

Thematic Category	Baseline Focus	Endline Focus	Illustrative Evidence
Conception of Equity	Primarily academic ability	Multifaceted (ability, gender, socioeconomic, geographical)	"students with poor background" (3702); "gender... to be considered" (3101)
Instructional Practice	Limited, ad-hoc strategies	Intentional use of UDL principles (multiple representations, collaborative learning)	"use... videos, real objects and group work" (3501); "principle of UDL" (3305, 3313)



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Discussion

The findings of this study demonstrate a significant positive impact of the CL4STEM project on teachers' pedagogical mindsets and classroom practices. Two central themes emerged from the analysis, namely evolving conceptions of equity and inclusion, and the adoption of UDL-aligned instructional practices. These themes collectively illustrate a transformation in teachers' understanding and application of inclusive pedagogy. A major outcome of the project was the deepened understanding of equity and inclusion among participating teachers. At the baseline stage, teachers' perceptions of learner diversity were limited and primarily focused on differences in academic ability, often described in binary terms such as "slow" and "fast" learners. However, by the midline and endline stages, teachers demonstrated a broader and more nuanced understanding of learner diversity. They began to recognize gender, socioeconomic status, family background, and geographical location as important dimensions influencing learning outcomes. For example, teachers identified that students from rural areas or low-income families faced unique challenges that required equitable and differentiated instructional responses. This evolution in teachers' thinking represents a shift from a narrow academic perspective to a more holistic appreciation of learners' varied circumstances. Such change aligns with the position of UNESCO (2020), which calls for educators to acknowledge and address the full spectrum of learner diversity as a foundation for meaningful inclusion, as also supported by Nguyen et al. (2020).

This expanded conception of equity was accompanied by a notable transformation in teachers' instructional practices. Evidence from the endline phase revealed that participants actively integrated principles of Universal Design for Learning (UDL) into their classroom teaching. Teachers adopted multiple means of representation by incorporating a variety of instructional materials, including videos and locally available teaching materials or realia, to enhance content accessibility and engagement. They also applied multiple means of action and expression through structured collaborative learning activities, enabling students of varying abilities to learn together and support one another. These practices reflect the translation of theoretical understanding into concrete classroom strategies, demonstrating teachers' increasing capacity to design inclusive lessons that accommodate diverse learner needs. The adoption of these strategies aligns with UDL guidelines on engagement, representation, and action and expression (Meyer et al., 2014) and supports previous studies that have shown the effectiveness of UDL in improving teaching and learning outcomes across diverse educational contexts (Elder et al., 2016; Yaki et al., 2019).

Furthermore, the explicit mention of UDL by several teachers in their reflections suggests that they were not only applying inclusive teaching techniques but were also engaging metacognitively with the framework. This indicates a deeper level of professional growth, as teachers were able to connect practice with theory and make intentional pedagogical decisions based on inclusive principles.

The success of this pedagogical transformation can be attributed to the thoughtful design of the CL4STEM intervention. The combination of curated Open Educational Resources (OER) and a mobile-based Community of Practice (CoP) created a dynamic environment for continuous professional learning. The OER modules provided practical and contextually relevant instructional materials rooted in UDL principles, while the CoP offered opportunities for sustained collaboration, mentorship, and reflective dialogue among teachers and facilitators. This integration of structured content and ongoing peer support aligns with the findings of Blanton et al. (2018), who emphasised that effective teacher professional development should be continuous, collaborative, and contextually



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grounded. The CL4STEM model, therefore, represents a scalable and context-sensitive approach to teacher capacity building that can effectively strengthen pedagogical competence and promote equitable, inclusive STEM education in resource-constrained settings.

Conclusion

This study concludes that the CL4STEM project effectively enhanced the capacity of science and mathematics teachers in Northern Nigeria to understand and implement equitable and inclusive pedagogical practices. The project's model, which integrates UDL-based OERs with a supportive, technology-facilitated Community of Practice, presents a viable and powerful approach to teacher professional development in resource-constrained environments.

Implications

The implications of this research are threefold: Educational policymakers in Nigeria and similar contexts should consider scaling and institutionalizing connected learning models like CL4STEM to achieve broader systemic impact on teaching quality and equity. Teacher training institutions should integrate UDL principles and community of practice models into both pre-service and in-service teacher education curricula. Future studies should employ mixed-methods or quasi-experimental designs to quantitatively measure the impact of these changed teaching practices on student learning outcomes and engagement in STEM subjects.

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Bridging Language and Agriculture ... Suleiman, B. & Mafindi, F. S. (2025)

Bridging Language and Agriculture: Enhancing English-as-a-Second-Language (ESL) Learning for Agricultural Development among Rural Community Youths in Nigeria

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Abstract

Rural Nigeria continues to face persistent challenges of poverty, food insecurity, and low literacy rates, compounded by high school dropout levels and limited access to quality education. A significant factor exacerbating this challenge is low English proficiency, which limits access to agricultural innovations, extension services, and government interventions often disseminated in English. This study investigates the integration of English as a Second Language (ESL) education with agricultural training as a dual approach to address both literacy and livelihood challenges in underserved communities dadinkowa and Dinki, Igabi Local of of Kaduna State, Nigeria. Using a mixed-methods design, 320 rural youth and school dropouts were enrolled in a three (3) months program combining ESL lessons with practical agricultural workshops. Eventually, 120 of the participants were given the questionnaire to respond to. Findings from the survey revealed that the program had a very poor impact on improving English proficiency among rural learners, there was no impact of Agricultural Skills and Practices on participants' farming productivity, Farmers never Link ESL and Agriculture to facilitate better adoption of agricultural practices, the program has promoted economic Empowerment, Inclusion, and Program Sustainability among rural women and youth, and there were some challenges that affect the sustainability of integrating ESL learning with agricultural development in rural communities. Based on the findings, the following recommendations were proffered; more training programmes on improving English proficiency among rural learners should be mounted, Emphasis should be made on Agricultural Skills and Practices so as to improve participants' farming productivity, Farmers should Link ESL and Agriculture to facilitate better adoption of agricultural practices.

Keywords: ESL, Agriculture, Rural Areas, Food Security, Literacy, Empowerment

Introduction

In Nigeria, the Western or modern Education in rural areas is characterized with so many obstacles including economic hardship, low socio-cultural achievements, and inadequate infrastructural facilities. In most communities in Nigeria, especially rural areas, a good number of children drop out of school with the motive to help their parents in farming, fishing, animal rearing and other activities. Those who are retained in the school, they received inadequate basic literacy and numeracy. These problems of increasing number of drop outs and inadequate literacy and numeracy, has long-term consequences for employability, self-reliance, and access to quality education. United Nations Development Programme (UNDP, 2020). Proficiency, skills and confidence in English Language as Nigeria's official language and medium of instruction, is an opportunity for getting employment and having access to education United Nations Educational, Scientific and Cultural Organization (UNESCO, 2020). Someone's level of Proficiency in English enables him have access to many



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economic, financial, agricultural extension services, government initiatives, and markets. Despite all efforts by government, NGO's and other relevant stakeholders, many communities in the rural areas still lack sufficient mastery of the English language skills, limiting their access and participation in agricultural, economic and other programs designed to improve their livelihood, United Nations Educational, Scientific and Cultural Organization (UNESCO, 2021).

In recent years, Agriculture remains the backbone of Nigeria's economy, providing employment for over 60% of the people living in both urban and rural areas (World Bank, 2020). Despite that fact, some Nigerians are still at the poverty level particularly those in the rural areas. This is due to inadequate knowledge and skills on subsistence farming and limited adoption and utilization of modern implements and techniques. According to reports by the FAO (2019), an inadequate language and communication skill hinders farmers at both urban and rural areas in Nigeria to have access to training manuals, extension services, and international market information. Therefore, this study proposes a dual intervention combining Language and communication skills and prompt agricultural training to empower farmers both at urban and rural areas.

Literature Review

There is the need, in today's world, for each and every individual to have basic literacy and numeracy irrespective of his or her field or area of business. Acquiring both literacy and numeracy skills enhances individual life and living standard. Therefore, the relationship between language acquisition, numeracy skills and vocational training has received a great concern in both developed and developing countries. Language skills when integrated with vocational and technical skills will result to economic and social development (Coyle, Hood, & Marsh, 2010). It's on the basis of that, content and Language Integrated Learning (CLIL) frameworks highlight that the English language curriculum provides students with both linguistic, subject-specific knowledge, and vocational skills towards achieving the Sustainable Development Goals (Coyle, Hood, & Marsh, 2010). For that reason, it's very important to incorporate content of ESL into vocational and technical programmes in particular agricultural training where learners will be trained on the application of the ESL to real-life language use (Mehisto, 2012).

In Nigeria, there are a lot of challenges of rural education which are mostly triggered by socio-economic realities. UNESCO (2021), emphasizes that there is limited access to quality education in most of the rural areas of Africa. This is usually associated with abject poverty, gender disparities, cultural or social believe, and weak infrastructure. These factors are in total contradiction to the SDG Goal 4, which emphasis on the provision of free and accessible education to all and sundry. These compounding problems, together with language barrier, affect economic, social and agricultural productivity of most people in Nigeria UNESCO (2021). According to UNESCO (2021), these challenges are aggravated by the language of instruction, which is predominantly English not the language of the immediate environment of the learners or farmers. In light of that, according to Krashen's (2022) Theory of Comprehensible Input, English as a second language can be proficiently learned if it's taught using hands-on minds-on activities. Therefore, the goals or objectives of teaching ESL should be learner centered, subject specific, community services having direct link with agricultural practice, where language learning is tied to daily human endeavors. Some studies revealed that Language and communication skills are very crucial in terms of Agriculture-specific studies which support economic and rural development. For instance, FAO (2019) reports that inadequate language and communication skills are the major roadblocks to the small-scale farmers from understanding manuals on fertilizers, pesticides, modern cultivation techniques, marketing



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strategies, preservatives, amongst others. Similarly, according to Odozi and Obinne (2019), rural farmers' lack of adequate English language and communication skills hinders them to communicate effectively and understand agricultural subsidies, how to operate machines, apply fertilizer and insecticides, and international trade opportunities. Therefore, once there is strong link between language and communication skills and agriculture, all the factors militating against large scale productivity in agriculture will be a history.

Statement of the Problem

In Nigeria, Farming remained as the major source of food and income. But still, low literacy level, English Language Communication skills and inadequate agricultural systems techniques are still the major challenges facing farmers in Nigeria. The persistent lack of basic literacy skills and higher productivity awareness among rural youth and women remain the major problems of farming in Nigeria. This became the major cause and source of poverty and food insecurity. Therefore, this study was on Bridging Language and Agriculture towards Enhancing ESL Learning for Agricultural Development in Rural Nigeria.

Objectives of the Study

1. To improve English proficiency among rural youth and school dropouts in Kaduna State.
2. To equip participants with modern Agricultural Skills for increased productivity and self-reliance.
3. To examine the relationship between English proficiency and the adoption of improved agricultural practices.
4. To promote economic Empowerment, Inclusion, and Program Sustainability among rural women and youth?
5. To evaluate the challenges that affects the sustainability of integrating ESL learning with agricultural development in rural communities?

Research Questions

1. How effective is the program in improving English proficiency among rural learners?
2. What is the impact of Agricultural Skills and Practices on participants' farming productivity?
3. How are Farmers Linking ESL and Agriculture to facilitate better adoption of agricultural practices?
4. How does the program promote economic Empowerment, Inclusion, and Program Sustainability among rural women and youth?
5. What are the challenges that affect the sustainability of integrating ESL learning with agricultural development in rural communities?

Methodology

The study adopted a survey design where both categorical and continuous data were collected and analysed. The population of the study involves all rural communities in Kaduna State with high dropout rates and reliance on subsistence farming. The population being infinite, the sample respondents will be accessed by going to the villages in Dadinkowa and Dinki rural community in Kaduna State. A sample of 120 participants (Drop out and youth) were involved in the study. According to Krejcie and Morgan Table of sample size determination, a minimum sample of 384 will be adequate to represent a finite population. The instruments were distributed to the respondents and collected on the spot.

Data Collection Instruments

The instrument used is titled "Enhancing ESL Learning for Agricultural Development in Rural Nigeria Questionnaire". The instrument is divided into six sections (A-F). Section A was for Demographic information of the respondents, while the remaining sections, B-F collected data that was used to



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address the research questions. Three research assistants were trained on how to administer the instrument.

Data Analysis

Quantitative data was collected and analyzed using descriptive statistics of charts, frequencies and percents.

Demographic Information

Table 1: Age of the respondents

Age group	Frequency	Percentage
18-25	34	9
26-33	122	31
34-41	103	26
42-49	76	19
50-57	31	8
58-65	24	6
Total	390	100

Figure 01: Age of the respondents

Table 01 present the age brackets of the respondents that participated in the study. About 122 are within 26-33 years old, followed by those in the class of 34-41 years. The least number belongs to the class of 56-65 years of age, followed by 50-57- years with 31 respondents. This shows that vast majority of those who attended the training are within the age of 26-41 (56%).

Table 02: Gender of the Respondents

Gender	Frequency	Percent
Male	314	80.51
Female	76	19.49
Total	390	100

Figure 02: Gender of the Respondents

Table 02 present the gender of the respondents that participated in the study. About 314 are male and only 76 are female. This indicated that more than 80% of the respondents are male while less than 20% are female.

Table 03: Highest Education Level of the Respondents

Education Level	Frequency	Percent
Non-formal education	186	47.69
Primary	97	24.87
Secondary	73	18.72
Post-secondary	34	8.72
Total	390	100

Figure 03: Highest Education Level of the Respondents

Table 03 present the highest education level of the respondents that participated in the study. The result revealed that 186 had non-formal education, 97 had primary education, 73 are with secondary education, and only 34 had post-secondary certificate. This is a clear indication that approximately about half of the respondents had non-formal education which made it difficult to understand the training.

Table 04: Main Occupation of the Respondents

Main Occupation	Frequency	Percent
Farming	192	49.23



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Trading	147	37.69
Student	34	8.72
Other	17	4.36
Total	390	100

Figure 04: Main Occupation of the Respondents

Table 04 present the main occupation of the respondents that participated in the study. The result revealed that 192 were farmers, 147 were traders, 34 were students, and 17 were in other forms of occupation not specified. This shows that approximately half of the respondents (50%) were farmers.

Table 05: Years of farming experience of the Respondents

Years of farming experience (if any)	Frequency	Percent
0-10	143	36.67
11-20	169	43.33
21-30	45	11.54
31-40	33	8.46
Total	390	100

Figure 05: Years of farming experience of the Respondents

Table 05 present the Years of farming experience of the respondents that participated in the study. The result revealed that 143 had 0-10 years experience, 169 had 11-20 years, 45 had 21-30 years, and only 33 had 31-40 years farming experience. This shows that approximately more than half of the respondents (80%) had 0-20 years farming experience.

Table 06: type of farming do you mainly practice

What type of farming do you mainly practice	Frequency	Percent
Crop	142	36.41
Livestock	102	26.15
Mixed	134	34.36
None	12	3.08
Total	390	100

Figure 06: type of farming mainly practice

Table 06 present the type of farming mainly practice of the respondents that participated in the study. The result revealed that 142 practice only crop farming, 102 were engaged in livestock production, 134 were practicing mixed farming, and 12 had indicated none practice of any type of farming. This shows that a reasonable percent (34%) were engaged in mixed cropping or farming.

Table 07: modern farming techniques learned through the program

Which modern farming techniques have you learned through the program? (Tick all that apply)	Frequency	Percent
Soil management	63	16.15
Pest control	47	12.05
Crop rotation	125	32.05
Irrigation	132	33.85
Others	23	5.9
Total	390	100

Figure 07: modern farming techniques learned through the program

Table 07 present the type of modern farming techniques learned during the training by the respondents that participated in the study. The result revealed that 63 learned soil management



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practice, 47 learned pest control, 125 learned crop rotation, 132 learned irrigation, while 23 indicated that they learnt different modern farming techniques through the programme.

Research Question 1: How effective is the program in improving English proficiency among rural learners?

Table 08: English Proficiency

Statement	Very poor		Poor		fair		Good		excellent		Total	
	f	%	F	%	f	%	f	%	F	%	f	%
How would you rate your ability to read in English?	133	34.1	109	27.95	87	22.31	31	7.95	30	7.69	390	100
How would you rate your ability to write in English?	147	37.69	113	28.97	63	16.15	51	13.08	16	4.1	390	100
How would you rate your ability to speak English in everyday life?	117	30	159	40.77	71	18.21	22	5.64	21	5.38	390	100
How confident are you when communicating with agricultural extension officers in English?	197	50.51	93	23.85	64	16.41	27	6.92	9	2.31	390	100
Since joining the ESL-Agriculture program, how was your English proficiency in speaking and communicating in English?	113	28.97	78	20	93	23.85	71	18.21	35	8.97	390	100
Average Total	141	36.2	111	28.3	77	19.3	40	10.3	56	5.6	390	100

Figure 08: English Proficiency

Table 08 present the level of English proficiency of the respondents that participated in the study. When asked on how they rate their ability to read in English, 133 (34.1%) said they read English very poor; poor 109 (27.95%); fair 87 (22.31%), good 31 (7.95%), and only 30 (7.69%) said they speak English fluently. On their ability to write in English, 147 (37.69%) write very poor; poor 113 (28.97%); fair 63 (16.15%); good 51 (13.08%) while only 16 (4.1%) write English excellently. In response to the question of how they rate their ability to speak English in everyday life, 117 (30%) shows that they apply English in daily life very poor; poor 159 (40.77%); fair 71 (18.21%), good 22 (5.64%) and 21 (5.38%) use it very excellently. About confidence in communicating with agricultural extension



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officers in English, 197 (50.51%) have very poor confidence; poor 93 (23.85%); fair 64 (16.41%); good 27 (6.92%) and only 9 (2.31%) have excellent confidence in communicating with agricultural extension officers in English. 113 (28.97%) Finally, when responding to the question on since when they join the ESL-Agriculture program, what was their level of English proficiency in speaking and communicating in English, 113 (28.97%) said their communication was very poor; poor 78 (20); fair 93 (23.85%); good 71 (18.21%) and only 35 (8.97%) said they speak and communicate in English excellently. The overall result revealed that 141 (36.25%) indicated that they speak English very poorly; 110 (28.31%) speak it poorly; 76 (19.39%) are fairly speaking English; 40 (10.36%) speak good English; and 22 (5.69%) speak English excellently. Therefore, the program had a very poor impact on improving English proficiency among rural learners.

Research Question 2:What is the impact of Agricultural Skills and Practices on participants’ farming productivity?

Table 09: Agricultural Skills and Practices

Statement	not at all		a little		somewhat		Much		very much		total	
	f	%	f	%	f	%	f	%	f	%	f	%
To what extent has the program improved your farming skills?	153	39.2	103	26.41	85	21.79	27	6.92	22	5.64	390	100
How does your farm yields increase since the training?	141	36.1	118	30.26	64	16.41	51	13.08	16	4.1	390	100
Do you use modern agricultural skills in pilot testing your experience from the training?	112	28.7	149	38.21	85	21.79	28	7.18	16	4.1	390	100
Has the training change your attitude towards farming practices after the training?	187	47.9	97	24.87	72	18.46	25	6.41	9	2.31	390	100



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Are the	109	27.9	83	21.28	11	28.97	63	16.15	22	5.64		
Skills you		5			3							
acquired												
very much												
relevant to												
your												
current												
farming												
practices?											390	100
Average	14	36	11	28.20	84	21.48	3	49.7	8	21.7		
Total	0		0	6		4	9	4	5	9	390	100

Figure 09: Agricultural Skills and Practices

Table 09 present the level of Agricultural Skills and Practices of the respondents that participated in the study. When asked on the extent to which the program improved their farming skills, 153 (39.23%) indicated that they didn't benefit at all; 103 (26.41%) benefitted a little; 85 (21.79%) benefitted somewhat; 27 (6.92%) benefitted much; and 22 (5.64%) benefitted very much. For the question on how their farm yields increased since after the training, 141 (36.15%) indicated no increase at all; 118 (30.26%) increased a little; 64 (16.41%) increased somewhat; 51 (13.08%) increased much; and 16 (4.1%) increased very much. On the use of modern agricultural skills in pilot testing their experience from the training, 112 (28.72%) indicated that they didn't use the skills at all; 149 (38.21%) use it a little; 85 (21.79%) use it somewhat; 28 (7.18%) use it much; and 16 (4.1%) use it very much. In response to the question of whether the training changed their attitude towards farming practices after the training, 187 (47.95%) indicated no change at all; 97 (24.87%) indicated a little change; 72 (18.46%) indicated that the attitudinal change was somewhat; 25 (6.41%) indicated that the change was much, and 9 (2.31%) indicated a very much attitudinal change after the training. Again, in response to the question of whether the Skills acquired are very much relevant to their current farming practices; 109 (27.95%) indicated that the skills are not relevant at all; 83 (21.28%) indicated that its of little relevance; 113 (28.97%) indicated that it's somewhat relevant; 63 (16.15%) indicated that its relevance is much; and 22 (5.64%) are of the view that the skills acquired are very much relevant to their current farming practices. The overall total indicated that 140 (36%) of the respondents indicated that there is no impact of Agricultural Skills and Practices on participants' farming productivity; 110 (28.21%) indicated that there is a little impact; 84 (21.48%) indicated that there was a somewhat impact; 39 (9.95%) indicated that there was a much impact; and 17 (4.36%) indicated that there was a very much impact of Agricultural Skills and Practices on participants' farming productivity. Therefore, there was no impact of Agricultural Skills and Practices on participants' farming productivity.

Research Question 3: How are Farmers Linking ESL and Agriculture to facilitate better adoption of agricultural practices?

Table 10: Linking ESL and Agriculture

Statement	never		Rarely		sometimes		Often		always		Total	
	f	%	f	%	f	%	f	%	f	%	f	%
How often do you use English	155	39.74	118	30.26	57	14.62	37	9.49	23	5.9	390	100



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terms related														
to														
agriculture														
(e.g.,														
fertilizer,														
harvest,														
irrigation) in														
your daily														
practice?														
Do you find it	141	36.15	123	31.54	63	16.15	47	12.05	16	4.1				
easier to														
understand														
agricultural														
manuals,														
instructions,														
or training														
sessions														
after														
improving														
your														
English?												390	100	
To what	123	31.54	142	36.41	71	18.21	33	8.46	21	5.38				
extent has														
learning														
English														
improved														
your ability														
to adopt														
modern														
farming														
practices?												390	100	
Do you feel	187	47.95	97	24.87	60	15.38	27	6.92	19	4.87				
better														
prepared to														
communicat														
e with														
agricultural														
officers,														
buyers, or														
NGOs														
because of														
your														
improved														
English?												390	100	



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Has English learning directly helped your farming activities at a point in time?	109	27.95	82	21.03	84	21.54	79	20.26	36	9.23		
Average	14	36.6	11	28.8	67	17.1	4	57.1	11	29.4	390	100
Total	3	7	2	2		8	5	8	5	8	390	100

Figure 10: Linking ESL and Agriculture

Table 10 present the level of English proficiency of the respondents that participated in the study. When asked on how often do they use English terms related to agriculture (e.g., fertilizer, harvest, irrigation) in their daily practice, 155 (39.74%) indicated that they never use the English terms; 118 (30.26%) indicated that they rarely use them; 57 (14.62%) indicated that sometimes they do use the terms; 37 (9.49%) use the terms often; and 23 (5.9%) always use the terms. In response to the question of whether they find it easier to understand agricultural manuals, instructions, or training sessions after improving their English, 141 (36.15%) never find it easier; 123 (31.54%) rarely find it easier; 63 (16.15%) sometimes find it easier; 47 (12.05%) often find it easier; and 16 (4.1%) always find it easier. On the extent to which learning English improved their ability to adopt modern farming practices, 123 (31.54%) indicated that they never have any improvement in their ability to adopt modern farming practices; 142 (36.41%) indicated that they rarely have improvement; 71 (18.21%) indicated they sometimes do have improvement; 33 (8.46%) they often do; and 21 (5.38%) indicated that they always have improvement in their ability to adopt modern farming practices. In response to the question on whether they feel better prepared to communicate with agricultural officers, buyers, or NGOs because of their improved English, 187 (47.95%) indicated they never feel better prepared to communicate with the various agricultural stakeholders; 97 (24.87%) rarely feel better prepared; 60 (15.38%) sometimes feel better prepared; 27 (6.92%) often feel better prepared; and 19 (4.87%) always feel better prepared to communicate with agricultural officers, buyers, or NGOs because of their improved English. Again, in response to the question of if English learning directly helped their farming activities at a point in time, 109 (27.95%) indicated that it has never helped them; 82 (21.03%) indicated that it rarely helped them; 84 (21.54%) indicated that it sometimes helped them; 79 (20.26%) are of the view that it often helped them; and 36 (9.23%) indicated that it always helped them at a point in time. The total responses revealed that 143 (36.67%) never feel better prepared to communicate with the various stakeholders; 112.4 (28.82%) indicated they rarely feel better; 67 (17.18%) indicated that they sometimes feel better; 44.6 (11.44%) indicated they often feel better; and 23 (5.9%) responded that they always felt better prepared to communicate with agricultural officers, buyers, or NGOs because of their improved English. Therefore, Farmers never Link ESL and Agriculture to facilitate better adoption of agricultural practices.

Research Question 4: How does the program promote economic Empowerment, Inclusion, and Program Sustainability among rural women and youth?

Table 11: Empowerment, Inclusion, and Program Sustainability

Statement	Yes		No		not applicable		Total	
	f	%	f	%	F	%	f	%



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Has the program helped you feel more confident in participating in community or market activities?	194	49.74	109	27.95	87	22.31	390	100
Has the program increased your involvement in household or farming decisions?	214	54.87	113	28.97	63	16.15	390	100
Has the program increased your motive in finding alternative job?	160	41.03	159	40.77	71	18.21	390	100
Has the program increased your yearly or monthly income?	254	65.13	102	26.15	34	8.72	390	100
Did you think of expanding your farming activities even after the programme?	198	50.77	78	20	114	29.23	390	100
Average Total	204	52.31	112.2	28.77	73.8	18.92	390	100

Table 11 present the level of English proficiency of the respondents that participated in the study. When asked on whether the program helped them feel more confident in participating in community or market activities, 194 (49.74%) choose yes, 109 (27.95%) choose no, while 87 (22.31%) indicated that the question is not applicable to them. For the question on whether the program increased their involvement in household or farming decisions, 214 (54.87%) said yes the program increased their involvement in household or farming decisions, 113 (28.97%) said no it doesn't increased their involvement in household or farming decisions, and 63 (16.15%) said the question is not applicable to them. While when they were responding to the question on whether the program increased their motive in finding alternative job, 160 (41.03%) agreed with the statement, 159 (40.77%) choose no, and 71 (18.21%) were indifferent. On how the program increased their yearly or monthly income, 254 (65.13%) are of the view that it has increased their income, 102 (26.15%) said no it doesn't increased their income, and 34 (8.72%) were totally ambivalent. Finally, for the question on how they think of expanding their farming activities even after the programme, 198 (50.77%) are thinking of expending their farming activities even after the programme, 78 (20%) don't have the intention, and 114 (29.23%) were totally thinking it's not applicable. The total response on how the program promote economic Empowerment, Inclusion, and Program Sustainability among rural women and youth, 204 (52.31%) of the respondents agreed that the program promote economic Empowerment, Inclusion, and Program Sustainability among rural women and youth, 112 (28.77%) said no it doesn't, and 74 (18.92%) are of the view that the question is not applicable. This shows that the program has promoted economic Empowerment, Inclusion, and Program Sustainability among rural women and youth.

Research Question 5: What are the challenges that affect the sustainability of integrating ESL learning with agricultural development in rural communities?

Table 12: Challenges

Statement	yes		no		not applicable		Total	
	f	%	F	%	F	%	f	%
Do you face some challenges in attending the training regularly?	173	44.36	129	33.08	88	22.56	390	100



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Is lack of proficiency in English language one of your setbacks in improving your farming activities?	214	54.87	113	28.97	63	16.15	390	100
Do you think lack of adequate finance is one of the problems you are facing to improve your farming activities?	281	72.05	102	26.15	7	1.79	390	100
Do you attribute your non-understanding of the skills during the training to Personnel responsible for the training not being very friendly and confident?	307	78.72	72	18.46	11	2.82	390	100
Do you agree that the training has no direct impact on your daily life?	289	74.1	78	20	23	5.9	390	100
Average Total	253	64.82	99	25.332	38	9.844	390	100

Table 12 present the level of English proficiency of the respondents that participated in the study. When asked if they encounter or face some challenges in attending the training regularly, 173 (44.36%) said yes they do, 129 (33.08%) said no they didn't encounter with any problem, and 88 (22.56%) said it is not applicable. On the issue of lack of proficiency in English language as one of their setbacks in improving their farming activities, 214 (54.87%) agreed that lack of proficiency in English language as one of their setbacks in improving their farming activities, 113 (28.97%) choose no as their response, and 63 (16.15%) choose the option of not applicable. For the statement of how they think lack of adequate finance is one of the problems they are facing to improve their farming activities, 281 (72.05%) choose yes, 102 (26.15%) choose no, and 7 (1.79%) choose not applicable. Again, on attributing their non-understanding of the skills during the training to Personnel responsible for the training not being very friendly and confident, 307 (78.72%) indicated that the personnel were not friendly and confident, 72 (18.46%) choose no, and 11 (2.82%) were of the view that the question is not applicable. Finally, in response the question of if they agree that the training has no impact on their daily life, 289 (74.1%) indicated that it has impact on their life, 78 (20%) indicate that it has no direct bearing to their daily life, and only 23 (5.9%) said the question is not applicable. The overall total response indicated that 253 (64.82%) agreed that there were some challenges that affect the sustainability of integrating ESL learning with agricultural development in rural communities, 99 (25.33%) indicated that there were no problems or challenges, and 38 (9.84%) were of the view that the question was not applicable. Therefore, there were some challenges that affect the sustainability of integrating ESL learning with agricultural development in rural communities.

Summary of Findings

1. The program had a very poor impact on improving English proficiency among rural learners.
2. There was no impact of Agricultural Skills and Practices on participants' farming productivity.
3. Farmers never Link ESL and Agriculture to facilitate better adoption of agricultural practices.
4. The program has promoted economic Empowerment, Inclusion, and Program Sustainability among rural women and youth
5. There were some challenges that affect the sustainability of integrating ESL learning with agricultural development in rural communities

Discussion of Findings



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1. The finding that English proficiency remained low aligns with Krashen's (1982) Comprehensible Input Theory, which emphasizes the need for contextual and sustained language exposure. In Dadin Kowa and Dinki, lessons were short-term and often interrupted by farming activities, limiting learners' linguistic gains.
2. The lack of significant agricultural improvement corresponds with Odozi and Obinne (2019), who noted that without comprehension of instructional language, technical training yields little productivity. This underscores the interdependence between language competence and agricultural effectiveness.
3. The third finding, that farmers rarely linked ESL with agriculture, echoes the concerns of FAO (2019) and UNESCO (2021) that language barriers hinder access to agricultural innovations. It suggests that language should not be treated as an isolated skill but embedded within agricultural demonstrations.
4. However, the program's positive impact on women's empowerment supports Nwajiuba (2016) and Yusuf (2021), who observed that literacy programs enhance women's agency in family and community decision-making.
5. Finally, the sustainability challenges observed mirror World Bank (2020) findings that rural education initiatives in Nigeria often fail due to poor funding, inadequate training, and weak institutional support. Addressing these gaps is essential for long-term success.

Recommendations

1. Strengthen ESL instruction through sustained, context-based language immersion using agricultural themes.
2. Incorporate bilingual facilitators fluent in English and Hausa to enhance comprehension and participation.
3. Integrate ESL with field demonstrations to make learning practical and directly relevant to farming.
4. Provide continuous funding and monitoring to sustain the ESL-agriculture integration initiative.
5. Empower women and youth cooperatives through literacy-linked agribusiness training and mentorship.

Conclusion

This study conducted in Dadin Kowa and Dinki villages of Igabi Local Government, Kaduna State, reveals that while integrating ESL with agriculture has potential to foster literacy and livelihood development. The outcomes remain limited without consistent pedagogical, financial, and structural support. The low level of English proficiency and weak linkage between language learning and agricultural practice hindered significant improvement in productivity. Nevertheless, the initiative demonstrated potential for community inclusion and economic empowerment, especially among rural women. Sustainable rural transformation, therefore, requires a holistic approach that fuses language education, vocational training, and community participation in long-term capacity development.

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Qualitative study on Collaborative Instructional Strategies on Academic Performance in Chemistry: A Systematic Approach

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Abstract

This paper examines the efficacy of collaborative learning approach in improving learner's academic performance in the field of chemistry. Collaborative learning is centered on peer-to-peer engagement and group activities. It has emerged as a potent pedagogical tool to foster deeper understanding and retention of chemical concepts. Common examples of collaborative learning strategies are jigsaw teaching strategy, peer teaching, problem-solving tasks, and project-based learning, among others. Research has established that this learning strategy has a positive impact on learners' cognitive development, logical thinking strategies, and academic performance. Additionally, the review has shown that collaborative learning approaches can be facilitated by using Information and Communication Technologies such as online collaboration platforms, virtual laboratories, and video conferencing platforms. Although collaborative learning approaches offer advantages, literature has also reported challenges specific to this learning strategy in teaching and learning of chemistry. This paper discusses these challenges and offers corresponding solutions. In conclusion, collaborative learning serves as a powerful catalyst for improving students' academic performance.

Keywords: performance, Collaborative learning, chemistry; Information and Communication Technologies

Introduction

Chemistry is the scientific study of chemical of matter, and the transformation it undergoes. According to Nnoli (2014), chemistry is an important discipline of science that enables the learner to have an environmental awareness. Chemistry is the basic key and gateway to modern technology (Okafor, 2022). At the local and worldwide levels, chemistry is a tool for national development. Anugwo et al. (2023) state that it is crucial in a variety of specialized fields, including industries, agriculture, transportation, housing, medicine, and engineering. According to Attahiru, Haruna, and



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Abubakar (2020), chemistry contributes to the provision of clean energy and a healthy environment for sustainable development and may be utilized to fight insecurity by, for example, identifying and classifying compounds found at crime scenes. According to Abdullahi, Lawal, and Isah (2020), chemistry knowledge may also be able to help reduce youth unemployment. In recognition of the importance of chemistry in development of a Nation, the National Policy on Science and Technology Education was developed by the Federal Government of Nigeria (FGN) in 2018 as part of its efforts to train competent science and technical teachers, including chemistry teachers. The policy's objective is to develop a vital scientific and technology workforce in Nigeria that can elevate the country's economy to a global level (Policy on S & TE, 2018). In addition, FGN has given out special grants including the TETFund, capital grants, and recurrent grants. Training of science teachers, including chemistry teachers, is the goal of these special grants (Toluwalop, 2016). Science education (chemistry education) researchers have also worked to enhance the learners' academic success in chemistry at the secondary and undergraduate levels by utilizing creative teaching methods and intervention therapies. For instance, Victor-Aigbodion et al. (2023), Ezeudu et al (2019) and Tôth (2023), did an intervention using rational emotive behavior therapy on undergraduate chemistry education students to manage academic burnout and depression so as to improve their cumulative grade point average. Ugwuanyi et al. (2020) used cognitive behavior therapy as an intervention to manage undergraduate students' academic procrastination at some Nigerian universities. Some science education (chemistry education) researchers adopted ICT-based innovative teaching strategies in a bid to improve students' academic achievement at the undergraduate level. Okafor (2022) used a virtual learning environment in a bid to allow students to interact with learning activities and reduce difficulties with chemistry concepts. This would then enhance students' academic engagement and achievement. Kolil, Muthupalani, and Achuthan (2022) adopted virtual laboratory platforms to improve students' analytical skills and reduce their anxiety while performing experiments. This was done to enhance their engagement and performance.

Okafor (2022) used a Google Meet learning environment to allow chemistry education students to interact with learning activities in order to improve their understanding of difficult chemistry concepts and increase collaboration among them. This would then enhance their academic achievement. Kolil, Muthupalani, and Achuthan (2022) used virtual laboratory platforms to improve chemistry education students' analytical skills and reduce anxiety toward performing experiments. This was expected to improve their engagement in learning and performance. Considering the efforts made by FGN and science education researchers toward improving students' academic achievement from secondary school level up to the undergraduate level, it is expected that students should demonstrate high academic achievement. According to Umate, Aminu and Hamza (2018), academic achievement is the knowledge, competencies or skills acquired by students in a school subject which is determined by the grades assigned by teachers, schools or examination bodies. Academic achievement at secondary school level is interpreted based on raw scores such as percentage pass or fail as well as standard scores such as Z-scores, T-score, Standard of Nine (STANINE). Academic achievement at university level is measured and interpreted as the Cumulative Grade Point Average (CGPA). CGPA is obtained by the scores on tests, assignments, practical work, examination, and lecture attendance of every student (Lawal, 2014). The Nigerian university system grades students' CGPA on a 5-point scale ranging from first class (4.50–5.00), second class honors (upper division) (3.50–4.49), second class honors (lower division) (2.40–3.49), third class honors (1.50–2.39), and v) pass degree (1.00–1.49). Because of the importance of chemistry in the technological advancement of any nation, as well as efforts made by FGN and science education or chemistry education



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researchers, it is expected that students will perform very well from secondary school level up to university level. However, studies reported that students perform unsatisfactorily both at the secondary school and university levels. According to the WAEC Chief Examiners' report from 2017–2021, chemistry students' performance fluctuated, and most show performance below 50%. Badmus and Omosewo (2018) also reported that students' performance in chemistry from 2007 to 2017 was below 50% except for 2013, 2014, and 2015, which were 72%, 62%, and 60%, respectively. In addition, WAEC Chief Examiners' Report for 2018-2023 revealed that chemistry students' performance has not been satisfactory. The students' CGPA at undergraduate level has been reported to be low in both private and public universities (Okafor, 2022; Eya, Okebannama, & Umate, 2020; Akunne, 2020). Furthermore, statistics of the chemistry education students' records in some Nigerian universities show that more than 50% of chemistry education students do not always graduate by the stipulated time.

Some researchers reported that the use of inappropriate instructional strategies in the teaching and learning of chemistry is the major contributory factor that led to unsatisfactory academic performance in chemistry from secondary school level up to university level. In order to resolve this issue of unsatisfactory performance, an innovative teaching strategy that provides learners with opportunities for manipulating learning activities individually and collaboratively should be adopted, as reported by Umate, Ahmad, and Ibrahim, (2021). One of the trending skills and competencies of the 21st century is working together to complete a task or offer a solution to a problem. One of the innovative teaching strategies that provides these opportunities to students is collaborative learning. Collaborative learning is a group of teaching strategies that allows groups of students to perform educational tasks. It allows individuals' active engagement and discussion in a coordinated manner to perform task, or reconstruct shared knowledge (Darko & Wang, 2021). It is an umbrella term for various instructional approaches to small group learning, including team-based learning, peer tutoring, study groups, project-based learning, problem-based learning, and learning communities (Yang, 2023). Collaboration refers to the interaction among peers where individuals are mindful of their actions, which include learning, contributing and respecting one another. According to this approach, in any group setting, individuals' abilities, skills, strength and input are taken into consideration. This suggests that group shared authority and holds joint responsibility for its decisions and outcomes (Niyonsaba, Nkurunziza, & Hakizimana, 2022). Center for Teaching Innovation of Cornell University (2023) reports that collaborative learning helps in advancing higher order thinking, communication skills, self-regulation, and administrative skills. It also helps in espousing learners to diverse perspectives, improve their understanding of concepts, prepares them for real life situations. There has been considerable research carried out on the effectiveness of this approach in improving students' academic achievement.

In Ghana, Darko and Wang, (2021) found that collaborative learning improved undergraduate business education students' learning and attitude. Ajayi and Ajayi (2020) reported that the collaborative learning strategy improves undergraduate students' learning success in science education. Niyonsaba, Nkurunziza, and Hakizimana (2022) revealed that Rwandan chemistry students exposed to chemistry contents using collaborative learning performed significantly better than those taught using traditional methods of teaching. Priyambodo, Fitriyana, Primastuti, and Artistic (2020) found that collaborative learning enhanced Indonesian learners' motivation as well as performance. Chang, Yan, and Lu (2022) reported that collaborative learning enhanced Taiwan students' academic performance in a programming course. Aku, Hussaini, and Gabi (2022) found



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that students taught concepts of energy using collaborative learning in Nasarawa state have high scores than with conventional methods of teaching. Research have established that collaborative learning helps in improving students' academic achievement. However, most of the studies were conducted with students from other nations, and some were carried out with students from area specializations such Physics, Business Education, computer science, among others. Most importantly, the use of collaborative learning is especially limited in the field of chemistry education despite its advantages and efficacy in improving academic achievement. From the foregoing, the unsatisfactory academic achievement among chemistry students from the secondary school level up to the university level has been a persistent problem that has left educational stakeholders in Nigeria worried. This is because chemistry is a vital tool for national development and technological advancement. The use of innovative teaching strategies such as collaborative learning approach can help chemistry students manipulate learning activities on an individual basis as well as on a group basis. This leads to improvements in students' academic achievement, retention, and collaboration. This in turn can help in resolving chemistry students' unsatisfactory academic achievement.

Statement of the Problem

As noted earlier, chemistry is a vital tool for the technological advancement of any nation and the world at large. Despite the roles chemistry plays in national development and daily activities, reports from WAEC Chief Examiners and some researchers revealed that students' performance in chemistry at secondary school has been unsatisfactory. At the undergraduate level, students' CGPA has been reported to be low in both private and public universities. Moreso, statistics of chemistry education students' records in some Nigerian universities show that more than 50% of chemistry education students do not always graduate by the stipulated time. (Umate, 2024). The federal government of Nigeria and science education researchers have made a lot of efforts to make sure that students perform better in their academic endeavors from secondary school up to undergraduate levels. This was done by establishing science and technical boards, developing policies, and carrying out research projects aimed at improving learners' performance, among others. Nevertheless, students' performance in chemistry from secondary level to undergraduate levels continues to be low.

If students' low academic performance in chemistry continues, it would pose a threat to the production of prospective science students who would study science-related areas of specialization such as medicine and pharmacy as well as the production of chemistry teachers in secondary schools and other tertiary institutions. This, in turn, will hinder the production of scientists and the technical workforce that are required to transform the nation's economic landscape into a world class economy. Researchers reported that the inability to adopt innovative instructional strategies such as collaborative learning is the major contributory factor for unsatisfactory students' academic performance in chemistry. Much research has been conducted on the relative effects and efficacy of collaborative learning in improving students' learning outcomes. Most of these studies used foreign samples whose results might not be generalizable to the Nigerian context, some of them were carried out with students from disciplines other than chemistry, and some used a limited sample size that might not generalize to other populations. These are the gaps that call for this study. Therefore, the problem of this study put in question form is: Would collaborative learning be a stimulus for improving students' academic performance in chemistry?

Theoretical Framework

This review is anchored on Socio-cultural Theory by Lev Vygotsky (1978). This theory was developed by Lev Vygotsky (1978). It posits that learning is a social process wherein individuals construct knowledge through interactions with others. According to Vygotsky, learners can achieve higher



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levels of understanding by engaging in collaborative activities, such as problem-solving, discussion, and joint projects. Social-cultural theory involves three key concepts: zone of proximal development, scaffolding, and internalization. Zone of Proximal Development (ZPD): Central to socio-cultural theory is the concept of the Zone of Proximal Development, or ZPD. This is the difference between what a learner can do independently and what they can achieve with the guidance and support of a more knowledgeable other, such as a teacher, peer, or parent. Vygotsky argued that learning should occur within the ZPD, as it allows for the scaffolding of learning experiences, leading to the development of higher-order thinking skills.

Scaffolding: Scaffolding refers to the support provided by a more knowledgeable other to help learners bridge the gap between their current level of understanding and their potential developmental level within the ZPD. This support can take various forms, such as modeling, prompting, questioning, and providing feedback. Through scaffolding, learners gradually internalize and master new concepts and skills. **Internalization:** According to socio-cultural theory, learning involves the internalization of cultural tools and practices through social interaction and participation in cultural activities. Through collaborative activities and guided instruction, learners gradually internalize the knowledge, skills, and strategies of their cultural community, transforming external social processes into internal cognitive processes.

Collaborative Learning and students' academic performance

Collaborative learning is a group of teaching strategies that involves the coming together of students in groups with an aim of achieving or completing a task. Ha Le (2018) defined collaborative learning as a set of teaching and learning strategies that promote students to work in small groups (two to five students) to complete tasks. This approach involves groups of students teaming together to perform or complete a task. Collaborative learning is “any form of learning that occurs due to social interaction between two or more individuals when they are working together on the same task or toward the same goal” (Naji & Croje, 2022). Collaborative learning is a group of teaching strategies whereby students work in groups to explore and manipulate learning activities. This could be a group of learners deliberating on class lessons or learners from different institutions of learning working virtually over the Internet to complete academic activities. It is based on the premise that learning occurs because of social interactions among the learners themselves, teachers, school and society. This approach allows students to actively engage in learning activities, process and synthesize information. They work in groups on projects, where everyone must contribute toward completing the project or assignment.

Collaborative learning comprises several approaches and strategies to teaching in education. It provides a platform for intellectual exercise between students, or students and their teachers. In this approach learners are put in small groups heterogeneously and monitored by their teacher(s) to perform or complete a task or academic activities (Lombardi, 2018). Collaborative learning helps learners to create both academic and social relationships to accomplish common goals and active control over their own learning process (Niyonsaba, Nkurunziza, & Hakizimana, 2022; Nkechinyere, Ordu, Harcourt, & Harcourt, 2018). According to Abubakar and Arshad (2015), collaborative learning helps in enhancing learners' learning and problem-solving skills. These problem-solving skills include communication, teamwork and high order thinking skills, among others. According to Leopold and Smith (2020) and Novita, Kurnia, and Mustofa (2020) collaborative learning has social, psychological and academic benefits. Social benefits include: i) developing social support for students, ii) building diverse understanding between students themselves and staff, iii) establishing



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a positive atmosphere for practicing cooperation and iv) developing learning communities. The Psychological benefits include i) increasing students' self-esteem, ii) Reducing anxiety among students iii) developing positive attitudes towards teachers. While Academic benefits: i) Promoting critical thinking, ii) encouraging students' active engagement and iii) motivating students to learn. Research has shown that collaborative learning approach is one of the vital tools that helps in improving students' academic performance. It is also one of the best teaching strategies that could be adopted for reducing abstractions and difficulties of some chemistry concepts (Abukari, et al., 2023). Chang, Yan and Lu (2022) reported that first year students of Taiwan University taught information management with collaborative learning exhibited higher improvements in academic performance. Abukari, et al., (2023) found that collaborative learning approach improved Ghanaian secondary school students' academic performance in organic chemistry. Achufusi-Aka and Okpanachi (2021) reported that collaborative learning strategy has a positive impact on learners' academic success in Chemistry compared to the conventional teaching method.

Adjei, Hanson, Sam, and Sedegah (2020) revealed that Ghanaian high school students taught redox reaction using collaborative learning had better academic achievement compared to those taught using conventional method of teaching. Kamanga and Shumba (2022) disclosed that Zambian pre-service chemistry teachers taught concept of environmental chemistry using collaborative learning demonstrated high academic performance. Kumar (2017) did a meta-analysis of effects of collaborative learning on the students' academic performance. The results revealed that collaborative learning has moderate effects on the students' academic performance. Jekayinfa, Durojaiye, and Oloda (2023) found that mathematics students taught with collaborative learning outperformed their counterparts taught with conventional teaching methods. Zambrano et al. (2019) disclosed that high-school Ecuadorian students' academic performance in mathematics improved significantly after teaching them with collaborative learning approach. Gaad (2022) reported that Philippines students' exposure to the Collaborative learning strategy was effective in facilitating significant improvements in their achievement and engagement in physical science.

A careful analysis of the literature revealed that collaborative learning could be used as a stimulus for improving students' academic performance. However, most of these studies were carried out with samples of students from disciplines other than chemistry. Some studies were conducted with samples of foreign students whose result might not be generalizable to Nigeria. There is also scarcity of studies in the field of chemistry education that utilize collaborative learning in teaching chemical concepts. Therefore, this study is advocating that collaborative learning approaches should be adopted in teaching and learning chemistry. This might help in resolving unsatisfactory chemistry students' academic performance from secondary school level up to the university level.

Forms of Collaborative Learning

Collaborative learning encompasses a variety of instructional methods and activities that promote interaction, cooperation, and shared knowledge construction among learners (Chang-Tik, 2022; Udvari-Solner, 2012; Laal, M., & Laal, M., 2012). Here are some common forms of collaborative learning:

1. **Group Discussions:** Group discussions involve learners engaging in conversations with their peers to explore concepts, share ideas, and deepen their understanding of the subject matter (Goshtasbpour, 2022). These discussions can be structured around specific topics, questions, or problems, and may take place in small or large groups, either in-person or online.



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2. Peer Teaching: Peer teaching involves students taking on the role of teachers to explain concepts, demonstrate skills, or facilitate learning activities for their classmates (Stigmar, 2016). This approach not only helps reinforce the material for the student teaching but also provides an opportunity for active engagement and learning for the entire group.
3. Collaborative Project: Collaborative projects require students to work together in groups to complete a task or solve a problem. These projects can take various forms, such as research projects, presentations, group reports, or creative productions. Collaborative projects encourage teamwork, communication, and the integration of diverse perspectives.
4. Jigsaw Technique: The jigsaw technique divides students into small groups, with each group member becoming an expert on a specific topic or aspect of a larger concept. After mastering their individual topics, students then reconvene in new groups composed of members from different initial groups, where they share their expertise to complete a comprehensive task or project.
5. Think-Pair-Share: Think-Pair-Share is a form of collaborative learning strategy that involves three steps: students first think individually about an academic task or question, then pair up discussing what was reflected on, and lastly share the ideas with the entire class. This approach promotes active participation and peer interaction.
6. Problem-Based Learning (PBL): In problem-based learning, students work in teams to solve relevant, real-world problems. PBL encourages inquiry the development of inquiry, problem-solving, and critical thinking skills. This occurs as students engage in self-directed learning and collaborative problem-solving.
7. Cooperative Learning Structures: Cooperative learning structures are instructional techniques designed to promote positive interdependence, individual accountability, collaborative skills, and group processing. Examples include the use of learning teams, reciprocal teaching, peer tutoring, and the use of roles and responsibilities within groups.
8. Student Teams-Achievement Divisions (STAD) is a collaborative learning framework in which students work in small groups to help master instructional content. According to Ishtiaq, Ali and Hussain (2020), this model consists of four stages: 1) direct instruction from the teacher, 2) collaborative teamwork, 3) individual quizzes and recognizing high achieving teams.

Strategies for Implementing Collaborative Learning in Chemistry

As noted by the Graduate School of Education and Human Development, George Washington University (2024), adopting collaborative learning in teaching requires careful planning and the use of various strategies to promote engagement and foster meaningful interactions among students. When these strategies are properly and effectively implemented, educators can create a collaborative learning environment in chemistry that fosters active engagement, enhances understanding of concepts, and promotes the development of critical thinking and communication skills (Achufusi-Aka & Okpanachi, 2021). Here are some strategies for implementing collaborative learning in chemistry:

1. Group Formation: Strategically form groups to ensure diversity in terms of knowledge, skills, and backgrounds. Consider factors such as students' academic abilities, interests, and learning styles when forming groups to maximize collaboration and peer learning.
2. Clear Learning Objectives: Clearly define learning objectives for collaborative activities to provide students with a sense of purpose and direction. Align these objectives with the specific chemistry concepts or skills you want students to learn or reinforce through collaboration.
3. Role Assignments: Assign specific roles or responsibilities to each group member to ensure active participation and accountability. Roles may include facilitator, note-taker, timekeeper,



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researcher, or presenter. Rotate roles periodically to provide all students with opportunities to develop different skills

4. Use of Technology: Integrate technology tools and platforms to facilitate collaboration and communication among group members. Virtual collaboration tools, online discussion forums, shared documents, collaborative document editing (e.g MS DOC and collaborative whiteboards) can enhance interaction and engagement, especially in virtual or hybrid learning environments.
5. Real-World Applications: Incorporate real-world applications and examples into collaborative activities to make chemistry concepts more relevant and engaging for students. Encourage students to apply their knowledge to solve authentic problems or analyze real-life scenarios related to chemistry.
6. Feedback and Reflection: Provide opportunities for students to give and receive feedback on their collaborative work and reflect on their learning experiences. Encourage self-assessment and peer assessment to promote metacognitive skills and continuous improvement.
7. Teacher Support and Guidance: Offer guidance and support to students throughout the collaborative learning process. Be available to answer questions, clarify concepts, and provide assistance as needed. Monitor group interactions and intervene when necessary to address any challenges or issues that arise.
8. Assessment and Evaluation: Develop assessment criteria and rubrics that assess both individual and group performance in collaborative activities. Evaluate students based on their contributions to group discussions, problem-solving skills, teamwork, and the quality of their collaborative outputs. Provide constructive feedback to help students identify areas for improvement.

Tools and Technologies for Facilitating Collaborative Learning in Chemistry

Some studies reported that collaborative learning can be greatly enhanced in chemistry with the use of various tools and technologies (Wohlfart, Wagner & Wagner, 2023; Iyamuremye, Mukiza, Nsengimana, 2023; Zamiri, & Esmacili, 2024). Some of these tools include:

1. Online Collaboration Platforms: Platforms like Google Workspace (formerly G Suite), Microsoft Teams, or Slack offer features like document sharing, real-time collaboration on documents, and communication channels. Students can collaborate on projects, share resources, and discuss concepts.
2. Virtual Laboratories: Virtual labs like ChemCollective, Labster, or PhET Interactive Simulations provide a safe environment for students to conduct experiments, explore chemical reactions, and visualize complex concepts. These tools often offer interactive simulations that mimic real laboratory experiences.
3. Video Conferencing: Platforms like Zoom or Skype can be used for virtual lectures, group discussions, and tutoring sessions. They allow for real-time interaction and screen sharing, enabling instructors to demonstrate experiments or explain concepts visually.
4. Online Whiteboards: Tools like Miro or Jamboard provide digital whiteboard spaces where students can brainstorm ideas, solve problems collaboratively, and visualize concepts. These platforms support drawing, writing, and importing images, making them versatile for chemistry-related activities.
5. Learning Management Systems (LMS): LMS platforms such as Moodle, Canvas, or Blackboard offer features for content delivery, discussion forums, quizzes, and assignment



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submissions. Instructors can organize course materials, track student progress, and facilitate discussions within the platform.

6. Interactive Multimedia Content: Websites like Khan Academy, ChemEd DL, or Chemguide offer interactive lessons, tutorials, and quizzes covering various chemistry topics. These resources engage students with multimedia content such as videos, animations, and interactive exercises.
7. Collaborative Document Editing: Tools like Google Docs or Microsoft Office Online enable real-time collaboration on documents, spreadsheets, and presentations. Students can work together on assignments, write reports, and provide feedback to each other seamlessly.
8. Online Assessment Tools: Platforms like Kahoot, Quizizz, or Socrative allow instructors to create interactive quizzes, polls, and surveys to assess student understanding. These tools make learning engaging and provide instant feedback to students.
9. Social media and Online Forums: Utilizing platforms like Reddit, Facebook Groups, or dedicated chemistry forums can foster community among students and provide a space for discussion, resource sharing, and peer support outside of the classroom.

Research has proven that by incorporating ICT tools and technologies into collaborative learning approach, instructors or teachers can create dynamic and interactive learning environments that foster collaboration, critical thinking, and deeper understanding of chemical concepts.

Challenges and Solutions in Collaborative Chemistry Learning

Collaborative learning in chemistry has some challenges due to individual difference and diverse nature of the students. According studies (Wang, 2022; Irzawati, 2023; SciSpace, 2024) Some common challenges and potential solutions for collaborative chemistry learning include:

1. Complexity of Concepts: Chemistry involves intricate concepts and abstract theories that can be challenging to grasp. In a collaborative setting, some students may struggle to keep up with the pace or understand certain concepts.

Solution: Encourage peer teaching and group discussions. Breaking down complex topics into smaller, digestible chunks can help students understand better.

2. Diverse Learning Styles: Students have different learning styles and preferences. What works for one student may not work for another, leading to disparities in understanding and engagement.

Solution: use variety of teaching aids that cater to different learning styles, such as visual aids, hands-on activities, and interactive simulations.

3. Time Management: Balancing collaborative chemistry projects with other coursework and commitments can be challenging for students, leading to procrastination and rushed work.

Solution: Break down larger projects into smaller, manageable tasks with clear deadlines. Encourage students to set realistic goals and create a timeline for completing each task. Monitoring progress regularly and providing guidance can help students stay on track.

4. Communication Barriers: Effective communication is essential for successful collaboration, but misunderstandings and miscommunication can occur, especially in diverse groups.



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Solution: Foster open communication by establishing clear expectations and guidelines for collaboration. Encourage active listening, respectful feedback, and constructive criticism within groups, compromise, and conflict resolution, among others.

5. Technical Challenges: Performing experiments and conducting research often require access to specialized equipment and resources, which may not be readily available to all students.

Solution: Explore alternative methods, such as virtual simulations and online laboratories, to supplement traditional hands-on experiments. Encourage students to collaborate with peers who have access to different resources and equipment, promoting a diverse range of experimental approaches.

When these potential challenges are appropriately addressed, and proposed solutions are effectively implemented, collaborative chemistry learning can be a rewarding experience that enhances students' understanding of the subject, promoting critical thinking, communication, and teamwork skills (Ijirana, Supriadi, & Magfirah, 2022; SciSpace, 2024).

Conclusion

Collaborative learning approach is a group of teaching strategies that allow students to work in small groups to achieve a common goal. It helps in improving students' academic performance. When it well planned and coordinated, it can also be used in improving students' academic performance in chemistry. This is done by fostering active engagement, peer interaction, and problem-solving skills. collaborative learning enhances students' understanding and appreciation of chemical concepts, ultimately leading to improved academic outcomes.

Recommendation

Here are some recommendations specifically tailored for adopting collaborative learning in teaching chemistry:

1. Curriculum Integration: Integrate collaborative learning activities seamlessly into the chemistry curriculum. Identify topics or concepts that lend themselves well to group work, such as laboratory experiments, problem-solving sessions, or case studies.
2. Provide Clear Instructions: Clearly communicate the objectives, expectations, and guidelines for collaborative activities to students. Ensure they understand their roles within the group and the purpose of the task.
3. Utilize Cooperative Structures: Implement cooperative learning structures such as think-pair-share, jigsaw, or peer tutoring to facilitate effective collaboration among students. These structures provide clear frameworks for interaction and participation.
4. Encourage Peer Teaching: Foster a culture of peer teaching and learning within collaborative groups. Encourage students to explain concepts to each other, ask clarifying questions, and provide feedback on their peers' understanding.
5. Facilitate Group Discussions: Act as a facilitator during group discussions, guiding students through the problem-solving process while allowing them to take ownership of their learning. Encourage active listening, respectful dialogue, and consensus building within the group.
6. Promote Critical Thinking: Design collaborative activities that require students to apply critical thinking skills to solve real-world chemistry problems. Encourage them to analyze data, draw connections between concepts, and propose hypotheses collaboratively.
7. Provide Resources and Support: Offer resources, materials, and guidance to support students during collaborative activities. Provide access to relevant textbooks, online resources, or laboratory equipment as needed to facilitate their exploration and experimentation.



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8. Assess Collaboration Skills: Assess not only students' understanding of chemistry concepts but also their collaboration skills and contributions to group work. Use rubrics or peer evaluations to evaluate teamwork, communication, and problem-solving abilities.

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Effects of Economic Status on ... Dargak, P. P. & Goyit, H. Y. (2025)

Effects of Economic Status on Utilization of Maternal Health-care Services among Child-Bearing Age Mothers in North-Central, Nigeria

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Abstract

This study assesses the effects of economic status on utilization of maternal health-care Services among child-bearing age mothers in North-Central, Nigeria. Ex-post facto research design was used for this study. Two (2) research questions and one (1) hypothesis guided the study. The population of six million, four hundred and thirty-five thousand, five hundred and six (6,435,506) respondents for the study consisted of all mothers of child bearing age in North central Nigeria. A sample size of one thousand, one hundred and fifty-two (1152) respondents were used for the study. A multi-stage sampling technique used to select the sample size. A close-ended questionnaire was used to obtain responses from the respondents. The instrument was reliable with 0.804. Descriptive statistics of means and standard deviations were used to answer the research questions. The formulated hypotheses were tested at 0.05 level of significance. The analysis of the result revealed that economic status significantly influenced the utilization of maternal healthcare services among mothers of child-bearing age in North-Central Nigeria ($p = 0.00 > 0.05$). It was, concluded that economic status influenced the utilization of maternal healthcare services among child-bearing age mothers in North-Central zone, Nigeria. Following recommendation made that Cost alleviation for mothers of child bearing age utilizing maternal healthcare services should be put in place by the state governments to encourage them to patronize maternal healthcare services.

Keyword: Maternal, healthcare services, utilization, women of child bearing age

Introduction

Maternal and reproductive health services in health care delivery system constitute a large range of curative and preventative health services of particular importance to the health of women of reproductive age. It includes a range of services provided to mothers of child bearing age prior to conception, during pregnancy, during and after delivery (Lule, Ramana & Rosen, 2018). Mother of child bearing age enjoys the benefits of healthcare services when she attends AnteNatal Care (ANC) and delivers in appropriate health facility, whereby pregnancy must be supervised by a trained health personnel and labour attended to by a skilled birth attendant (World Health Organization, 2021). Furthermore, the mother on her part is expected to book early and attend adequate number of ANC prior to delivery, although, ANC attendance has been measured based on the proportion of mothers who have attended ANC at least once during pregnancy. This explains why World Health Organization (WHO) (2020), recommended that pregnant women should attend ANC at least 4 times starting from the first trimester. Consequently, some advocates have argued for the adoption of focused ANC care services, in which case a woman attends ANC four (4) times during pregnancy at specific intervals as recommended by WHO, which allows for adequate attention to be given to each pregnant woman while high risk pregnancies are better monitored (Villar & Bergsjö, 2019).



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The importance of utilizing maternal healthcare services particularly in developing countries cannot be overemphasized (Melkamu, 2018), for instance, ANC helps to ensure the wellbeing of the mother and fetus through early detection of risks in pregnancy, prevention of pregnancy and labor complications and ensures the safety of mother and child. Furthermore, it exposes mothers of child bearing age to counseling and education about their own health and the care of their babies. With the strong positive association that has been shown to exist between level of care obtained during pregnancy and the use of safe delivery care, ANC also stands to contribute indirectly to maternal mortality reduction (Babalola & Fatusi, 2018).

According to Syed, Goran, Max and Zarina (2011), individual economic status emerged as one of the major determinants influencing utilization of maternal healthcare services and healthcare expenditure among mothers of child bearing age. With low household incomes and dependency on cultivation as the major source of revenue, factors such as fees for care provider, cost of medicine and costs of transportation are obstacles in utilizing healthcare services. Similarly, Rahman, Kielmann, McPacke and Normand (2012), reported that economic status is one of the main determinants influencing the choice of treatment and care provider accessed by mothers of child bearing age. The need for maternal healthcare service varies in space and so the organization of provision necessarily has a special component. The spatial dimension is important in utilizing the maternal healthcare services since accessibility is a major determinant of the use of maternal healthcare services (Omachi, 2018). Death and illness related to pregnancy and childbirth are significant health problems in North-Central zone, Nigeria, particularly in rural areas (Doctor, 2017). North central zone is one among the 6 (six) geo-political zones in Nigeria that have been formulating various strategies such as safe motherhood and community involvement. However, for the government and other stakeholders to take suitable actions to improve maternal health care services successfully, accurate information towards the problem that relies on empirical investigation is needed.

Statement of the Research Problem

The rates of morbidity and mortality among mothers of child-bearing age are avoidable through timely utilization of maternal healthcare services. Regrettably, utilizing skilled healthcare remains low in Nigeria, especially in North-Central Nigeria where home-based birth is the norm. Routine healthcare services, especially during the postpartum period are low. When mothers of child-bearing age use maternal healthcare services, they may prefer remedies from traditional healers rather than skilled health workers may be because of poor economic status. Economic status of mothers of child bearing age may determine if they can afford quality ANC service which will enable them gain access to good medical care during pregnancy and before delivery. But due to their poor financial status they may find it very difficult to access and afford these quality medical services. The existence of these problems prompted the researchers to ask the question, do economic status as a determinant really influence the utilization of maternal healthcare services? If yes, to what extent does a mother of child-bearing age utilize the maternal healthcare services within their society at large? At this point in time, no definite answers can be given to this question due to the existing gap in this research. Thus, the focus of this study hinges on the extent to which socio-demographic determinants could influence utilization of maternal healthcare services among child-bearing age mothers in North-Central zone, Nigeria.

Objectives of the study

The objectives of the study are to assess:



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1. Economic status as determinant of utilization of maternal healthcare service among child bearing age mothers in North-Central zone.
2. Utilization of maternal healthcare services among child bearing age mothers in North-Central zone of Nigeria

Research Questions

The following research questions were raised to guide the study:

1. What is the influence of economic status on utilization of maternal healthcare services among child-bearing age mothers in North-Central zone, Nigeria?
2. How often do child bearing age mothers utilize maternal healthcare services in North-Central zone of Nigeria?

Hypothesis

The following hypothesis were tested at 0.05 level of significance

1. Economic status does not significantly influence the utilization of maternal healthcare services among child-bearing age mothers in North-Central zone, Nigeria.

Methodology

Research Design: The descriptive survey research design of ex-post facto was used in this study. This research design was employed because the information gathered already existed with the respondents and, therefore, not under the control of the researcher.

Population

The population for this study comprised of six million four hundred and thirty-five thousand, five hundred and six (6,435,506) respondents (National Bureau of Statistics, 2024) that is all mothers of child bearing age in the six (6) States of North-central zone and Federal Capital Territory Abuja, inclusive.

Sample and Sampling Technique

The sample size for the study consisted of 1152 mothers of child bearing age which was drawn from the population of 6,435,506 mothers of child bearing age utilizing maternal healthcare services. To select the desired sample for this study, multistage sampling technique which involved stratified sampling techniques, simple random sampling, proportionate sampling and systematic sampling techniques were used. According to Research Advisor (2006), a population of more than 6,000,000, the sample size for the study is 384 at 5% margin of error and 95% confidence interval. Therefore, in order to make adequate generalization for this study the more the sample size, the better the coverage and therefore generalization of results. The suggested sample of 384 was therefore tripled (3) ($384 \times 3 = 1152$).

Instrument for Data Collection

The research instrument used for this study was a closed ended questionnaire titled: "Economic status as a determinant of maternal healthcare services among child bearing age mothers in North central zone, Nigeria". The questionnaire consisted of (2) sections. To score the responses of the respondents, as based on how they felt towards a particular item, the 4-point modified Likert scale was used as follows: Strongly Agree (SA) =4; Agree (A) =3; Disagree (DA) =2; Strongly Disagree (SD) =1. Therefore, any mean score of response that was 2.5 and above was considered acceptable or positive and any mean score of response that is below 2.5 was not acceptable but regarded as negative.



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Validity of Instrument

In order to determine the face and content validity of the research instrument, the draft copies of the structured questionnaire were submitted to five (5) experts in the Departments of Human Kinetic and Health Education, Nursing Science and Veterinary Medicine of Ahmadu Bello University, Zaria for vetting.

Pilot Study

To ascertain the reliability and internal consistency of the instrument for the study, simple random sampling was used to select sixty (60) mothers of child bearing age drawn from Kwara state which was not a sampled state used during the main study. The instrument was reliable with 0.804

Data Collection

In order to achieve the purpose of the study, a letter of self-introduction was produced by the researchers introducing themselves and the purpose of the study to the sampled states and local government areas.

Statistical Analysis

Mean and standard deviations were used to answer the research questions, while, Pearson’s Product Moment Correlation coefficient (PPMCC) test was used to test the null hypothesis. Hypothesis were tested at 0.05 level of significance.

Presentation of Results

Research Question One

How often do child bearing age mothers utilize maternal healthcare services in North-Central zone of Nigeria?

Table 1: Mean Score of Responses on Utilization of Healthcare Services among Child Bearing Age Mothers in North-Central zone, Nigeria

S/N	Variable Name	Mean	Std. Deviation	Decision
1	How often was your blood pressure checked during antenatal care	2.93	1.12	Most often
2	Health personnel often educate me on the importance of nutrition during antenatal care	2.77	1.00	Most often
3	How often was your body weight measured during prenatal care	2.63	0.87	Most often
4	How often were you screened for malaria during prenatal care	2.59	0.85	Most often
5	How often is your fetal position checked during antenatal care	2.51	0.72	Most often
6	How often were you counseled and enlightened by health personal on the importance of nutrition during antenatal care	2.55	0.73	Most often
7	How often do you maintain personnel hygiene during prenatal care	2.88	1.10	Most often
8	How often do you go for physical examination during prenatal care	2.76	0.98	Most often
9	How often was your child taken for immunization during postnatal care	2.54	0.72	Most often
10	How often was your urine screened during prenatal care	2.50	0.72	Most often
Aggregate mean score		2.67	0.88	

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Table 1 shows that child bearing age mothers most often utilize maternal healthcare services as all of the mean scores of responses were above 2.50. The result in Table 2 revealed that the blood pressures of child bearing age mothers are most often checked during antenatal care. Aside the blood pressure of child bearing age mothers being checked during antenatal care, respondents also indicated that personnel hygiene is most often maintained, health personnel most often educate child bearing age mothers on the importance of nutrition during antenatal care and they often go for physical examination during prenatal care as indicated by mean scores of 2.88, 2.77 and 2.76 respectively. The aggregate mean score of 2.67 and standard deviation of 0.88 indicated that healthcare services are most often utilized among child bearing age mothers in North Central Zone of Nigeria. This is evident in the mean score of 2.64 which was greater than the benchmark mean of 2.50.

Research question Two: What is the influence of economic status on utilization of maternal healthcare services among child-bearing age mothers in North-Central zone, Nigeria?

Table 1: Mean Score of Responses on Economic Factor Influencing Utilization of Healthcare Services among Child-bearing Age Mothers in North-Central zone, Nigeria

S/N	Variable Name	Mean	Std. Deviation	Decision
1.	I always attend antenatal healthcare services at expected time because I have my transportation fare	3.50	0.95	Influenced
2.	The low cost of STD (HIV) screening motivate me to go for antenatal healthcare services	2.94	0.93	Influenced
3.	The low cost of drugs during postnatal healthcare services motivate me to go for healthcare services	2.85	1.03	Influenced
4.	I delay in screening for signs of complication (swollen lags and anaemia) during pregnancy for lack of money	3.06	1.13	Influenced
5.	I prefer consulting traditional healers because of inability to pay for checking of fetal position.	3.12	0.98	Influenced
6.	I resort to available home remedies during pregnancy because of lack of money to go for immunization against neonatal tetanus	3.01	0.97	Influenced
7.	I visit traditional healers for lack of money for urine screening	2.92	1.06	Influenced
8.	I make use of delivering care from traditional birth attendants for lack of money to go for skilled birth attendants	3.09	1.00	Influenced
9.	The low cost of high-quality services offered by nurses who receive delivery motivate me to go there for care often	2.88	0.95	Influenced
10.	I rarely attend postnatal healthcare center because it is expensive.	2.81	0.98	Influenced
Aggregate mean score		3.02	1.00	

Field work 2025

Table 2 showed that the respondents agreed that economic factors influenced the utilization of maternal healthcare services as all of the mean scores of responses were above 2.50. The most desired healthcare services has to do with modern maternal healthcare services which was influenced by the economic situation of the respondents as reflected in items 1, 2, 3 and 9 in which



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attendance was determined by variable transport fare, low cost of STD (HIV) screening, low cost of drugs during prenatal healthcare and low cost of high-quality services offered by nurses respectively. However, the economic factor has made the child bearing age mothers in North central zone of Nigeria to highly subscribe the services of the traditional antenatal services as against the modern healthcare services. This is reflected in items 4, 5, 6, 7, 8 and 10 in which they delay in screening, preferred traditional healers, resorted to home remedies, visit tradition healers, used tradition birth attendants and rarely attended postnatal healthcare services respectively. The aggregate mean score of 3.02 and SD of 1.00 indicated that economic determinants influence the utilization of maternal healthcare services among child bearing age mothers in North Central Zone of Nigeria. This is because the aggregate mean of 3.02 is greater than the benchmark mean of 2.50 set for acceptance of the statement.

Hypothesis 1

Economic status does not significantly influence the utilization of maternal healthcare services among child-bearing age mothers in North-Central zone of Nigeria

Table 3: Correlation on Influence of Economic Status on Utilization of Maternal Healthcare Services among Child Bearing Age Mothers

Variables	Mean	SD	Df	r-cal	p-value	Decision
Economic Determinants	30.18	6.99				
Utilization of Maternal Healthcare Services	32.93	8.48	1442	0.68	0.00	Influenced

r-crit at df (1442)= 0.09 P<0.05

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Table 3 revealed that the mean score of 30.18 with standard deviation of 6.99 for economic determinants against a mean of 32.93 and standard deviation of 8.48 for utilization of maternal healthcare services. The economic status positively influenced the utilization of maternal healthcare services, which was statistically significant ($r = 0.68$, $p = 0.00$). Based on the result, the null hypothesis which stated that economic status as determinant of maternal healthcare services does not significantly influence the utilization of maternal healthcare services among child-bearing age mothers in North-Central zone of Nigeria was, therefore, rejected. This is because the p-value of 0.00 was less than the 0.05 level of significance implying that economic status as determinant has influence on the use of maternal healthcare services among child-bearing age mothers in North-Central Zone of Nigeria.

Discussion of Findings

The findings of this study revealed that economic status significantly influenced the utilization of maternal healthcare services among child bearing age mothers in North Central Zone of Nigeria ($P = 0.00$). This is in line with Syed, Goran, Max and Zarina (2011), study one economic Factors Influencing Maternal and Child Health Service Utilization in Mwingi. Observed that economic status emerged as one of the major determinants influencing utilization of maternal healthcare services and healthcare expenditure among mothers of child bearing age in Mwingi ($P = 0.00$). Furthermore, economically disadvantaged mothers of child bearing age North central zone of Nigeria make less use of preventive care and screening services. Thus, morbidity and premature mortality are disproportionately concentrated among the economically disadvantaged mothers of child bearing age in North central zone of Nigeria. It's also agreed with explanations of Owoseni (2016), who examined the Factors Affecting the Utilization of Antenatal Care among Pregnant Women in Moba LGA of Ekiti State, Nigeria. The studies have demonstrated that mothers of child bearing age in Moba LGA of Ekiti



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State, Nigeria with high economic status are significantly more likely to utilize early and adequate maternal healthcare services than those with low economic status. In the same vein, Roberts (2013), conducted research on timing of first antenatal care attendance and associated factors among pregnant women in Arba Minch Town and Arba Minch District, Gamo Gofa Zone, South Ethiopia. The researchers indicated that household wealth plays an irrefutable role among mothers of child bearing age in Arba Minch District, Gamo Gofa Zone, South Ethiopia in terms of utilization of maternal healthcare services: rich households are up to five times more likely to utilize delivery care than poor households in North central zone of Nigeria. The finding of this study also agreed with Dagne (2010), who conducted research on the Utilization of maternal health care services in Nigeria.

Conclusion

Based on the findings of this study, it was concluded that: Economic status influenced the utilization of maternal healthcare services among child bearing age mothers in North Central Zone of Nigeria.

Recommendation

The following recommendation is hereby made in view of the conclusion of this study.

1. Cost alleviation for mothers of child bearing age utilizing maternal healthcare services should be put in place by the state governments to encourage them to patronize maternal healthcare services.

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Correlation Between Innovative Leadership Practices and Growth of Small and Medium Scale Enterprises in Otukpo Local Government Area of Benue State, Nigeria

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Abstract

This study investigates the Correlation between Innovative Leadership practices and Growth of Small and Medium Scale Enterprises in Otukpo Local Government Area of Benue State, Nigeria. The study aimed to identify commonly adopted innovative leadership practices, examine their influence on business growth, and explore the barriers hindering their adoption. It was a quantitative research design which deployed a structured questionnaire that was administered to 120 SME owners and managers via simple random sampling method. Descriptive statistics and inferential analysis was used to analyse data. The results indicated a positive and significant correlation between innovative leadership practices and growth of SMEs, with key practices being strategic decision-making, openness to change and customer oriented innovation. The study recommends targeted training, improved funding mechanisms, and supportive policy frameworks to foster innovation-driven leadership among SMEs. In this study, the literature has been added in terms of the context-specific information about the role of leadership innovation in increasing the performance of SMEs in the semi-urban contexts of Nigeria.

Keywords: Innovative leadership, SME growth, business development, leadership practices

Introduction

Innovation, in the current business environment, has become a crucial ingredient to sustainable growth of any enterprise and specifically in Small and Medium Scale Enterprises (SME) cases. Leadership style embraced by SME owners and managers is of great significance to make an organization more innovative, adaptable, and competitive. The use of SMEs to support employment as well as to reduce poverty is well documented in Nigeria, but in the country, the majority of SMEs continue to challenge a sustainable growth because of poor leadership practices, poor innovation capabilities, and a lack of strategic direction (Udoyiu et al., 2024).

Creative leadership, which emphasis on creativity, adaptability, taking risks and innovation thinking characterized by such leadership has come to be associated with better measures of SME performance in terms of profitability, market expansion and customer retention (Ajayi & Adeyeye, 2023; Olubiyi, 2024). It has been indicated that experimental leaders, empowering employees, and utilisation of new technologies place them in a better position to overcome uncertainties and build



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long-term value (Chukwuemeka, 2021; Gonzalez-Varona et al., 2024). SMEs in Otukpo LGA of Benue State have a socio-economic environment with minimal access to capital, infrastructural gaps and variability in demand cycles. The SMEs are still considered as the engine of non-oil sector in Nigeria and they make up more than 90 percent of all businesses in the country contributing to GDP and employment.

Innovative leadership usually encourages free flow of information, group effort, experimentation, and flexibility qualities that are suited to the current business needs. As Joel and Oguanobi (2023) highlighted, entrepreneurial leadership in the form of proactive thinking and managing risk is inseparable in the resilience of startups and SMEs. Likewise, Okafor and Oluka (2025) supported that firm performance is directly influenced by strategic innovation management in various situations of SMEs in Nigeria. These results should be further investigated within the local context of Otukpo with the aim of answering the question of whether these trends are relevant or not and to what degree leadership-based innovation can become a driver of growth within environments that are poorly researched SMEs. The paper, therefore, will analyze the particular aspects of innovative leadership that is evident among the operators of SME in Otukpo LGA, evaluate their relationships with indicators of business growth and propose pertinent policy and practical measures that may enhance the development of the local businesses.

Objectives of the Study

The main objective of this study is impact of innovative leadership on the growth of Small and Medium Scale Enterprises (SMEs) in Otukpo Local Government Area of Benue State, Nigeria

The specific objective of this study is:

1. Identify the forms of innovative leadership practices adopted by SME owners and managers in Otukpo LGA.
2. Examine the relationship between innovative leadership and business growth in SMEs.
3. Evaluate the challenges hindering the adoption of innovative leadership among SMEs in Otukpo LGA.

Research Questions

The study will provide answers to the following research questions so as to achieve the research objectives;

1. What innovative leadership practices are commonly adopted by SME owners and managers in Otukpo LGA?
2. How does innovative leadership influence business growth in SMEs within Otukpo LGA?
3. What are the major barriers to adopting innovative leadership practices among SMEs in the study area?

Null Hypothesis

The study will test this hypothesis in other to achieve the research objective;

Ho: There is no significant relationship between innovative leadership and business growth in SMEs

Methodology

Research Design

The study adopted a descriptive survey research design. The choice of this design was appropriate since it enabled the researcher to attain responses of a large sample of SME operators in their natural settings, hence, gaining a proper reflection of their leadership experience and growth experience in businesses. The survey method also leads to quantitative management of the correlation of innovative leadership and growth of SMEs.



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Population of The Study

The population of this study comprises all registered small and medium-scale enterprise (SME) owners and managers in Otukpo Local Government Area of Benue State. Based on the information provided by the Benue State Ministry of Commerce and Industry (2024), it is possible to state that the number of all located SMEs operating in the LGA amounts to about 450 currently registered enterprises. These are companies in the retail, hospitality, agro-processing, manufacturing and service industries.

Sample and Sampling Techniques

A sample size of 120 SME owners and managers was drawn from the population using a purposive sampling technique. Such sampling technique was correct due to the fact it allowed selecting respondents who are directly linked to the process of leadership within their businesses and therefore able to provide the most common information about the leadership practices and business development.

The selection was guided by criteria such as:

1. The business must have been in operation for at least two years.
2. The respondent must be an owner, co-owner, or in a managerial leadership role.

This approach ensures that only informed and experienced participants contributed to the data set, improving the study’s reliability.

Validity of Instrument

The expert review involved the questionnaire with three academic researchers with any different backgrounds of business administration, entrepreneurship, and educational research in order to guarantee both the content and the face validity. Items which were ambiguous or leading or double-barreled were revised based on the feedback of the experts. Prefacing of the instrument was also carried out on 10 SME owners who were not included in the final sample and were found in a nearby LGA of Makurdi. The concept was established by this pilot test as regards the clarity, suitability, and relevance of items.

Method of Data Collection

The researcher personally administered the questionnaires to selected SME owners and managers in Otukpo LGA. The collection of data took two weeks to get adequate coverage. Respondents were briefed on the purpose of the study and assured of the confidentiality and anonymity of their responses. Participation was voluntary, and informed consent was obtained before administering the questionnaires.

Method of Data Analysis

The data collected were analyzed using descriptive and inferential statistics. Descriptive statistics such as frequency counts, percentages, and mean scores were used to summarize the demographic characteristics and responses to each questionnaire item. Inferential statistics, particularly the Pearson Correlation, were used to test the hypotheses and determine the strength and direction of the relationship between innovative leadership and SME growth. The Statistical Package for Social Sciences (SPSS) was employed for data analysis, with significance level set at 0.05.

Presentation of Data And Results

Distribution of Respondents

Table 1: Sex of Respondents

Sex	Frequency	Percentage (%)
Male	65	56.5%
Female	50	43.5%



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Total	115	100.0%
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Source: Author’s Compilation of Questionnaire, 2025

The demographic distribution of respondents reflects a relatively balanced representation across gender, age, education, and occupation. In terms of sex, male respondents constituted the majority at 56.5%, while females made up 43.5%, indicating a moderate male dominance in the sample.

Table 2: Age of Respondents

Age Group	Frequency	Percentage (%)
18–25	20	17.4%
26–35	30	26.1%
36–45	35	30.4%
46–55	20	17.4%
56 and above	10	8.7%
Total	115	100.0%

Source: Author’s Compilation of Questionnaire, 2025

The age distribution reveals that the majority of respondents fall within the 36–45 age group (30.4%), followed by 26–35 (26.1%) and 18–25 and 46–55 age brackets, both at 17.4%, while only 8.7% were aged 56 and above. This suggests a concentration of respondents within the economically active and working-age population.

Table 3: Educational Qualification of Respondents

Educational Level	Frequency	Percentage (%)
Primary	10	8.7%
Secondary	25	21.7%
OND/NCE	30	26.1%
HND/B.Sc.	35	30.4%
Postgraduate	15	13.0%
Total	115	100.0%

Source: Author’s Compilation of Questionnaire, 2025

The educational qualifications of respondents show a fairly educated sample, with the highest number holding HND/B.Sc. degrees (30.4%), followed closely by OND/NCE holders (26.1%). Secondary school graduates accounted for 21.7%, while 13.0% had postgraduate qualifications, and 8.7% had only primary education. This distribution suggests that the majority of respondents possess at least some form of tertiary education, which may influence their understanding and perception of financial or institutional systems

Table 4: Occupation of Respondents

Occupation	Frequency	Percentage (%)
Farmer	20	17.4%
Civil Servant	25	21.7%
Trader	30	26.1%
Student	20	17.4%
Unemployed	20	17.4%
Total	115	100.0%

Source: Author’s Compilation of Questionnaire, 2025

Regarding occupation, the distribution is relatively even across categories, with traders forming the largest group at 26.1%, followed by civil servants at 21.7%. Farmers, students, and the unemployed each represented 17.4% of the total sample.



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Table 5: Years of occupation of Respondents

Occupation	Frequency	Percentage (%)
1- 3 years	20	17.4%
3-6 years	25	21.7%
7-10 years	30	26.1%
11-14 years	20	17.4%
15+ years	20	17.4%
Total	115	100.0%

Source: Author's Compilation of Questionnaire, 2025

The data presented in Table 5 provides a breakdown of the respondents' years of occupation. A total of 115 respondents participated in this segment of the study. The largest group, comprising 30 respondents or 26.1%, reported having between 7–10 years of occupational experience. This indicates a substantial portion of the sample has mid-level experience, which may imply a relatively mature understanding of business dynamics and leadership practices. The next significant category is the 3–6 years group, which accounts for 25 respondents or 21.7% of the total. Respondents with 1–3 years, 11–14 years, and 15+ years of experience each contributed equally, with 20 respondents in each group, making up 17.4% respectively.

Answering the Research Questions

Research Question 1: What innovative leadership practices are commonly adopted by SME owners and managers in Otukpo LGA ?

Table 7: Mean and standard deviation on the innovative leadership practices are commonly adopted by SME owners and managers

S/N	Item	SA	A	D	SD	Mean	SD
B1	Strategic thinking is regularly applied in guiding the direction of the enterprise.	40	45	20	10	3.00	0.93
B2	New ideas and creative solutions are consistently encouraged and implemented.	35	50	18	12	2.94	0.94
B3	Risk-taking is actively supported as part of leadership decision-making.	30	40	30	15	2.74	0.99
B4	Technology is frequently leveraged to improve business processes and customer engagement.	28	42	35	10	2.77	0.92
B5	Collaboration and open communication are prioritized as leadership practices.	32	50	25	8	2.92	0.88

Source: Author's Compilation of Questionnaire, 2025

The analysis of Table 7 reveals key insights into the innovative leadership practices commonly adopted by SME owners and managers in Otukpo LGA. Strategic thinking appears to be a moderately strong leadership practice, with the highest mean score of 3.00 and a standard deviation of 0.93, indicating a general consensus among respondents on its application. Encouragement and implementation of new ideas also receive high support (mean = 2.94), suggesting a culture that values creativity. Similarly, collaboration and open communication (mean = 2.92) rank closely, implying that interpersonal and team-driven approaches are recognized. Risk-taking, while acknowledged (mean = 2.74), shows slightly more variation in responses, suggesting some hesitancy or inconsistency in its adoption. Technology use, with a mean of 2.77, reflects moderate engagement,



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possibly pointing to resource or capacity limitations. All in all, the innovative leadership seems to exist in conjunction with some inequality in applying it to the essential areas.

Research Question 2: How does innovative leadership influence business growth in SMEs within Otukpo LGA?

Table 8: *Mean and standard deviation on how innovative leadership influence business growth in SMEs within Otukpo LGA*

S/N	Item	SA	A	D	SD	Mean	SD
C1	Innovative leadership has led to increased profitability and market share.	38	46	22	9	2.98	0.91
C2	Customer satisfaction has improved as a result of leadership-driven innovation.	40	43	25	7	3.01	0.90
C3	Innovative strategies have expanded the range of products or services offered.	36	45	26	8	2.95	0.90
C4	Leadership innovation has contributed to increased employee productivity.	34	42	30	9	2.88	0.92
C5	The enterprise has experienced measurable growth due to the adoption of new business models and practices.	30	48	30	7	2.88	0.87

Source: Author’s Compilation of Questionnaire, 2025

Table 8 evaluates how innovative leadership influences business growth in SMEs. The answers indicate a positive attitude in the majority regarding the influence of what it does to people. Improved customer satisfaction ranks highest (mean = 3.01), highlighting that leadership innovation is visibly tied to enhanced client experience. Profitability and market share (mean = 2.98), alongside product/service diversification (mean = 2.95), also show strong associations with innovative practices, suggesting tangible business benefits. Increased employee productivity (mean = 2.88) and growth through new business models (mean = 2.88) receive slightly lower means, hinting that while leadership innovation contributes to internal efficiency and structural evolution, the effects may not be uniformly realized or are still emerging.

Research Question 3: What are the major barriers to adopting innovative leadership practices among SMEs in the study area?

Table 9: *Mean and standard deviation on the major barriers to adopting innovative leadership practices among SMEs in the study area*

S/N	Item	SA	A	D	SD	Mean	SD
D1	Limited access to capital restricts the implementation of innovative practices.	42	40	22	11	2.98	0.97



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D2	Resistance to change among employees hinders leadership innovation.	40	42	20	13	2.95	0.99
D3	Lack of exposure to modern leadership training limits innovation potential.	35	38	30	12	2.83	0.98
D4	Inadequate infrastructure and technology serve as constraints to innovation.	32	40	28	15	2.77	1.00
D5	Government policies and regulatory issues discourage innovative practices.	33	41	26	15	2.80	1.00

Source: Author's Compilation of Questionnaire, 2025

Table 9 explores the major barriers to adopting innovative leadership practices. Limited access to capital is identified as the most significant barrier (mean = 2.98), with relatively low variability in responses (SD = 0.97), emphasizing financial constraints as a key limitation. Resistance to change among employees closely follows (mean = 2.95), indicating that internal organizational culture is another substantial hurdle. Lack of exposure to leadership training (mean = 2.83) points to gaps in knowledge and capacity building. Infrastructure and technology constraints (mean = 2.77) as well as unfavorable government policies (mean = 2.80) round out the list, suggesting that external environmental and institutional factors also play non-trivial roles in impeding innovation. The standard deviations close or more than 1.00 of the some of the items indicate different experiences of SMEs on these obstacles. All in all, the evidence reveals a combination of financial, human and systematic barriers to the use of innovative leadership in the region.

Discussion Of Findings

The findings of this study provide compelling evidence regarding the impact of innovative leadership on the growth of Small and Medium Scale Enterprises (SMEs) in Otukpo Local Government Area of Benue State. Based on data analysis, it was found that the practice of innovative leadership there is moderately popular among the owners and managers of SMEs in the region. All these practices seemed to be in place like strategic thinking, promoting new ideas, open communication, risk-taking, and adoption of technologies though the extent of its practice differs. Strategic thinking and generation of ideas scored the highest meaning that SME leaders are aware that they have to think ahead and promote creativity to remain in the game. However, comparatively lower mean scores in technology adoption and risk-taking suggest a cautious and resource-constrained approach to innovation, which could be limiting their growth potential. In the analysis of barriers to innovative leadership, the results have shown that SMEs in Otukpo deal with a complex situation. Major setbacks which have been found to hinder it include access to finance, resistance to change. The regression analysis also confirmed the positive correlation of the relationship between innovative leadership and growth of a business which was found to be very strong and statistically significant. The model had an R-squared value of 0.936 and the beta coefficient equaled 0.887 indicating that the degree of innovative leadership manifested explains a major portion of the variance of growth in SMEs.

Conclusion

This study examined the impact of innovative leadership on the growth of Small and Medium Scale Enterprises (SMEs) in Otukpo Local Government Area of Benue State. The findings revealed that



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while innovative leadership practices such as strategic thinking, openness to new ideas, and customer-centered innovation are moderately embraced by SME owners and managers, challenges such as inadequate access to finance, poor infrastructure, and limited leadership development opportunities hinder the full realization of their growth potential. The statistical analysis further confirmed a strong positive relationship between innovative leadership and SME growth, indicating that firms led by innovation-oriented leaders are more likely to achieve improved performance, customer satisfaction, and adaptability in a competitive business environment. Thus, fostering innovative leadership is not just a strategic necessity but a critical determinant of business success in the SME sector.

Recommendations

Based on the findings, the following recommendations are offered to enhance the practice and impact of innovative leadership among SMEs in Otukpo LGA:

1. SME owners and managers should be encouraged to adopt a more proactive and flexible leadership approach by engaging in continuous learning, leadership training, and exposure to best practices in innovation management.
2. Government agencies and private institutions should support SMEs by creating platforms for leadership development, mentorship, and access to business advisory services.
3. Access to finance should be improved through targeted micro-credit schemes, innovation grants, and low-interest loans that enable SMEs to invest in technology and innovation.
4. SMEs should embrace a culture of experimentation and calculated risk-taking, which are essential attributes of innovative leadership and necessary for long-term sustainability.
5. Collaboration between SMEs and academic institutions should be strengthened to bridge the knowledge-practice gap and foster research-informed leadership development.

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Leveraging on the Fourth-Industrial-Revolution on Digital Skills Acquisition among undergraduate students in Tai-Solarin University of Education, Ogun State, Nigeria

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Abstract

The study leveraging on the fourth- industrial-revolution on digital skills acquisition among undergraduate students in Tai-Solarin University of Education, Ogun State. Two research questions guided the study. A descriptive survey research design was used for the study. The population of this study comprised undergraduates of Educational Technology in Tai Solarin University of Education (TASUED). 95 undergraduates of the Department of Educational Technology were selected as sample size of the study using stratified sampling technique. A self-researcher-designed instrument tagged Fourth Industrial Revolution (4IR) and Undergraduates Digital Skills Acquisition Questionnaire (4FIRUDSAQ) was used for data collection with reliability coefficient 0.88. Descriptive statistics of mean and standard deviation were used for answering research question 1. Research question 2 was answered using PPMC. The findings of the study revealed that coding, data analytics, data literacy, digital marketing, online safety, problem solving, cloud computing, artificial intelligence, blockchain technology and collaboration digital skills were among digital skills needed by undergraduates to functions effectively in the labour market for the Fourth Industrial Revolution (4IR) ($3.10 > 2.50$). There was a positive relationship between Fourth Industrial Revolution (4IR) and digital skills acquisition among undergraduate students in Tai Solarin University of Education ($r = 0.468, p < .05$). The study recommended that undergraduates should be encouraged to be lifelong and life-wide learners to develop the capabilities needed in ever changing world.

Keywords: Artificial Intelligence, Digital Skills, Fourth Industrial Revolution (4IR), Undergraduates

Introduction

Undergraduates need strong digital skills to thrive in today's academic and professional landscapes. These skills are not just about using technology, but also about effectively navigating, evaluating, and creating in a digital world. Digital literacy empowers undergraduates with the ability to succeed in their studies, pursue diverse career paths, and contribute to a rapidly evolving digital society. Digital skills are crucial for finding, evaluating, and using information effectively for research papers, projects, and assignments. Apata et al. (2025) stated that digital tools facilitate access to online learning resources, interactive learning platforms, and collaborative projects, enhancing the learning experience. Undergraduates need to be proficient in using digital communication tools for academic discussions, group projects, and presentations, likewise, employers across all sectors increasingly require digital literacy skills, making these skills essential for graduates seeking employment. Digital skills enable undergraduate to adapt to new technologies and evolving work environments (Adeoye et al., 2022). It opens doors to diverse job opportunities, both within traditional industries and emerging digital fields and streamline workflows, improve productivity, and enable more efficient task management. Digital skills equip undergraduates with the skills to navigate the online world responsibly, including understanding online safety, ethical communication, and data



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privacy. Digital literacy skills also foster the ability to critically evaluate online information, identify misinformation, and participate in informed discussions. Digital skills empower undergraduates to not just consume digital content but also to create, share, and contribute to the digital landscape. In essence, digital skills are no longer optional; they are fundamental for undergraduates to succeed in their studies, prepare for their careers, and become responsible and engaged digital citizens. However, digital skills acquisition refers to the process of learning and developing the abilities needed to effectively use digital technologies, tools, and platforms (Adewale, 2022). This encompasses a wide range of competencies, from basic computer and internet navigation to more advanced skills like data analysis, coding, and cybersecurity. It's about becoming digitally literate, which includes understanding how to find, evaluate, use, manage, and create information in digital environments. This includes fundamental skills like using computers, navigating the internet, sending emails, and using common software like word processors and spreadsheets (Akinyemi et al. 2023). Digital skills are crucial in the Fourth Industrial Revolution (4IR) because they are essential for navigating and thriving in an increasingly automated and technology-driven world (Olubiyo, 2024). The 4IR, characterized by the convergence of physical, digital, and biological spheres, relies heavily on technologies like AI, robotics, and the Internet of Things. This necessitates a workforce equipped with the technical expertise to develop, implement, and manage these technologies, as well as the adaptability to learn and adapt to new skills as they emerge.

The Fourth Industrial Revolution (4IR), also known as Industry 4.0, is characterized by the fusion of technologies that blur the lines between the physical, digital, and biological spheres. This revolution builds upon the digital revolution and is marked by the integration of cyber-physical systems, the Internet of Things (IoT), cloud computing, and artificial intelligence (AI). Essentially, it's a new era of innovation that's transforming how we live, work, and interact with the world. The 4IR involves the convergence of various technologies like AI, IoT, robotics, 3D printing, biotechnology, and nanotechnology (Ndung'u & Signe, 2019). It also refers to the integration of physical processes with digital technologies, creating systems that can monitor, control, and interact with the physical world. 4IR relies heavily on data collection, analysis, and real-time insights to optimize processes and decision-making. 4IR technologies enable smart factories, smart cities, and the interconnectedness of devices and systems, leading to increased automation and efficiency. AI algorithms are used for automation, data analysis, and decision-making in various industries. IoT connects physical devices to the internet, allowing for data exchange and remote control. Robots are increasingly used in manufacturing, logistics, and other sectors to automate tasks and improve efficiency. Additive manufacturing allows for on-demand production, customization, and rapid prototyping.

Advancements in biotechnology are leading to new materials, personalized medicine, and other innovations. Manipulating matter at the atomic and molecular level has the potential to revolutionize various industries. 4IR technologies are expected to boost productivity, create new industries, and transform existing ones. 4IR is likely to impact the way we work, learn, and interact with each other, potentially leading to new social structures and challenges (Ndung'u & Signe, 2019). The development and deployment of 4IR technologies raise ethical questions about privacy, security, and the potential for job displacement. Individuals, businesses, and governments need to adapt to the rapid pace of technological change and develop new skills to thrive in the 4IR. In essence, the Fourth Industrial Revolution represents a significant shift in how we interact with technology and how technology shapes our world. It's a period of unprecedented innovation and transformation with the potential to bring about both great benefits and significant challenges. the Fourth Industrial



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Revolution (4IR) combines technological and human capacities in an unprecedented way through self-learning algorithms, self-driving cars, human-machine interconnection, and big-data analytics (David-West, 2021). The 4IR involves the integration of these technologies into various sectors, requiring individuals who can understand, build, and maintain them. As automation becomes more prevalent, digital skills become vital for roles that involve managing, monitoring, and optimizing automated processes, rather than solely performing repetitive tasks. The 4IR generates massive amounts of data. Digital skills in data science, analytics, and interpretation are crucial for extracting valuable insights and making informed decisions. The pace of technological advancements in the 4IR is rapid, meaning skills can quickly become outdated. Therefore, individuals need to be adaptable and embrace lifelong learning to stay relevant (Olubiyo, 2024).

The 4IR requires continuous upskilling and reskilling to acquire new digital competencies and stay ahead of the curve. Digital skills, encompassing the ability to use and understand digital technologies, is fundamental for participating effectively in the 4IR. While technical skills are essential, the 4IR also emphasizes the importance of soft skills like problem-solving, critical thinking, and creativity, which are less susceptible to automation. Working in teams, communicating effectively, and collaborating on projects, often remotely, are crucial in the 4IR. Navigating the complexities of the 4IR also requires emotional intelligence, including the ability to manage stress, adapt to change, and collaborate effectively. Understanding AI principles, developing AI models, and using machine learning algorithms are becoming increasingly important. In conclusion, the Fourth Industrial Revolution necessitates a workforce equipped with a diverse set of digital skills, coupled with the adaptability and lifelong learning mindset needed to thrive in a rapidly evolving technological landscape. In the shadowed corridors of modern learning, 4IR revolution is not merely a flickering technological trend; it's a haunting metamorphosis that beckons lecturers and undergraduates into a realm where the boundaries between digital and physical dissolve into an eerie, interconnected tapestry (Adeoye et al. 2022). At its core lie transformative technologies that seem to whisper promises of infinite potential yet carry an undercurrent of profound change. Among the most pivotal are the core technologies driving 4IR in education, each wielding a dark allure of innovation. Artificial intelligence, for example, transforms classrooms into personalised sanctuaries, where algorithms adapt lessons to individual learners' needs. The Internet of Things (IoT) creates a web of interconnected devices, linking undergraduates and lecturer across vast distances, an invisible network pulsing with life and knowledge.

Data analytics, often unseen but omnipresent, enables the crafting of customised learning journeys, revealing patterns that lie beneath the surface of traditional pedagogy. Artificial Intelligence (AI) as personal tutors guiding each student through their unique odyssey. Augmented Reality (AR) and Virtual Reality (VR), conjuring immersive worlds that make history, science, and art come alive in spectral detail. Big data analytics, which unearths hidden insights, allowing education to evolve with uncanny precision. As these technologies intertwine, they forge a new paradigm, one that challenges the ancient foundations of education, inviting us into a future where learning is no longer confined within the confines of a classroom but expands into an infinite, shadowy expanse of possibility (David-West, 2021).

Statement of the Problem

The Fourth Industrial Revolution is rapidly transforming economies worldwide. Many see it as a catalyst for national prosperity, economic growth, and widespread improvements in living standards, fueled by cutting-edge technologies. However, the Fourth Industrial Revolution (4IR), while offering



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numerous opportunities, also presents significant challenges. These include addressing ethical concerns related to technologies like Artificial Intelligence (AI), managing data privacy and security, ensuring equitable access to technology, and the need for widespread workforce reskilling. Furthermore, the 4IR can exacerbate existing inequalities, disrupt labor markets, and create new security risks. Individuals and organizations, equipped with digital literacy and skills, are undoubtedly key drivers of this revolution. They promote the adoption of new technologies, boosting productivity, job security, and employment opportunities. Beyond economics, digital skills empower undergraduates to participate effectively as digital citizens, navigating online platforms and tools to engage in society, politics, and government. Consequently, a nation with a critical mass of digitally literate citizens and workers is better positioned to reap the benefits of the digital economy and drive an equitable digital transformation. Countries are increasingly focusing on fostering digital literacy and skills development through policies and programmes. However, these efforts are often hampered by challenges like inadequate funding, unreliable electricity, limited internet access, high maintenance costs, a lack of qualified personnel, resistance to change, and even a deficit of self-control. Even, studies on the extent to which 4IR shapes digital skills acquisition among undergraduates in universities have received less attention in Nigeria, the few one was conducted outside the shore of the country. Hence, this look into leveraging on the fourth- industrial-revolution on digital skills acquisition among undergraduate students in Tai-Solarin University of Education, Ogun State

Objectives of the Study

The main objective of the study was to leveraging on the fourth- industrial-revolution on digital skills acquisition among undergraduate students in Tai-Solarin University of Education, Ogun State. Specifically, the study sought to examine the:

1. digital skills needed by undergraduates to functions effectively in the labour market in Fourth Industrial Revolution (41R) among undergraduate students in Tai Solarin University of Education;
2. relationship between Fourth Industrial Revolution (41R) and digital skills acquisition among undergraduates in Ogun State Tai Solarin University of Education

Research Questions

The following research questions were answered in this study:

1. What are the digital skills needed by undergraduates to functions effectively in the labour market in Fourth Industrial Revolution (41R) among undergraduate students in Tai Solarin University of Education?
2. Is there any relationship between Fourth Industrial Revolution (41R) and digital skills acquisition among undergraduates in Ogun State among undergraduate students in Tai Solarin University of Education?

Methodology

A descriptive survey research design was used for the study. The design is appropriate because it assisted the researcher to establish and collect needed data from the target audience towards answering research questions of the study. The population of this study comprised undergraduates of Department of Educational Technology in Tai Solarin University of Education (TASUED). 95 undergraduates of Department of Educational Technology in Tai Solarin University of Education (TASUED) were selected as sample size of the study using stratified sampling technique. A self-researcher-designed instrument tagged Fourth Industrial Revolution (41R) and Undergraduates Digital Skills Acquisition Questionnaire (4FIRUDSAQ) was used for this study. 4FIRUDSAQ was used for the collection of data from respondents on digital skills needed by undergraduates to functions effectively in the labour



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market in Fourth Industrial Revolution (4IR); and issues or challenges facing Fourth Industrial Revolution (4IR) in shaping digital skills acquisition. The questionnaire requested responses on a four (4) – point scale format which is a modification of 5-point Likert scale. To ensure the face and content validity of the instrument (4FIRUDSAQ), copies of the instrument were given to an expert in the Department of Educational Technology, Tai Solarin University of Education (TASUED) for content corrections, after all the identified corrections have been affected, the final drafts were used to gather the required data for the study. Reliability test of the instrument (4FIRUDSAQ) was done using a test-retest method. In this case, copies of the instrument (4FIRUDSAQ) were administered twice on 20 undergraduates of Department of Educational Technology, University of Ilorin, that are not part of the sample size within a week interval. The collected data from the dual administration of the instruments were compared using Pearson Product Moment Correlation (PPMC). It was reported that reliability coefficient yielded 0.88. Primary method of data collection was adopted in this study. Primary method includes the usage of questionnaire to collect data from the identified respondents. Descriptive statistics of mean and standard deviation were used for answering research question 1. Research question 2 was answered using Pearson Product Moment Correlation (PPMC).

Presentation Results

Research Question 1: What are the digital skills needed by undergraduates to functions effectively in the labour market in Fourth Industrial Revolution (4IR) among undergraduate students in Tai Solarin University of Education?

Table 1: Descriptive statistics on the digital skills needed by undergraduates to functions effectively in the labour market in Fourth Industrial Revolution (4IR) among undergraduate students in Tai Solarin University of Education

Items	Mean	SD
Coding skills	3.18	.999
Data analytics skills	3.11	.905
Data literacy skills	3.04	.957
Digital marketing skills	2.94	.884
Online safety skills	3.28	.923
Problem solving skills	3.33	.894
Cloud computing skills	3.24	.985
Artificial Intelligence skills	2.67	1.232
Blockchain technology skills	2.95	1.044
Collaboration digital skills	3.21	.947
Cluster Mean	3.10	

Source: Field Survey, 2025

Fig 1: Bar-chart showing digital skills needed by undergraduates to functions effectively in the labour market in Fourth Industrial Revolution (4IR) among undergraduate students in Tai Solarin University of Education

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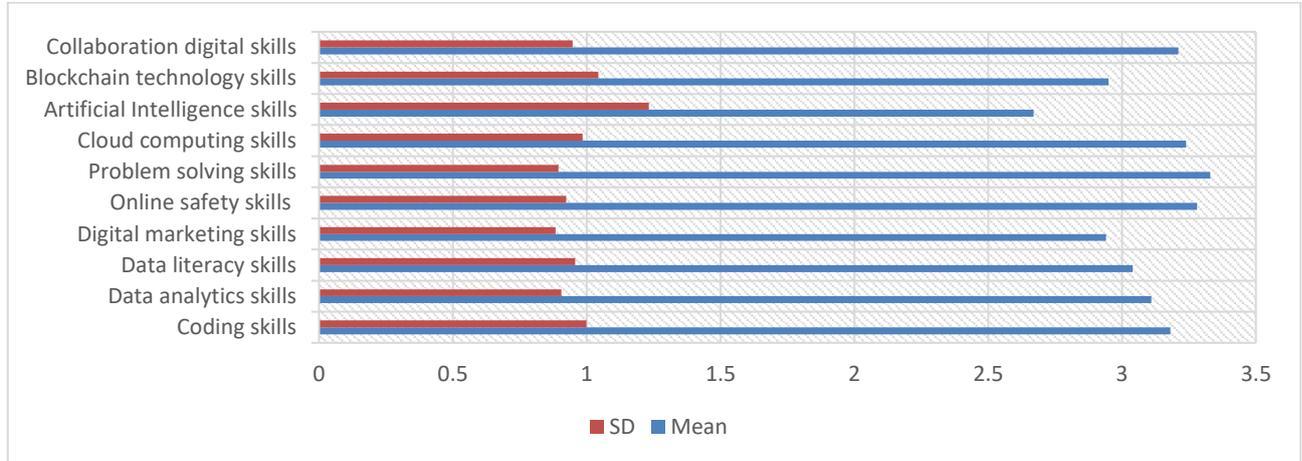


Table 1 revealed that cluster mean was reported as 3.10 and bench mark mean value was 2.50. The implications of this result were that $3.10 > 2.50$. This further that coding, data analytics, data literacy, digital marketing, online safety, problem solving, cloud computing, artificial intelligence, blockchain technology and collaboration digital skills were among digital skills needed by undergraduates to functions effectively in the labour market in Fourth Industrial Revolution (41R).

Research Question 2: Is there any relationship between Fourth Industrial Revolution (41R) and digital skills acquisition among undergraduates in Ogun State among undergraduate students in Tai Solarin University of Education?

Table 2: Relationship between Fourth Industrial Revolution (41R) and digital skills acquisition among undergraduates in Ogun State among undergraduate students in Tai Solarin University of Education

Variables	Mean	SD	df	r-value	p-value
Digital skills acquisition	39.87	12.04			
Fourth Industrial Revolution (41R)	28.99	9.392	93	.468	.001

Source: Field Survey, 2025

Table 2 depicted that there was significant relationship between the independent variable and the dependent variable in the order of ($r = 0.468, p < .05$). On this premise, the researcher concluded that there was a positive relationship between Fourth Industrial Revolution (41R) and digital skills acquisition among undergraduates in Ogun State.

Discussion of Findings

Research question 1 revealed that coding, data analytics, data literacy, digital marketing, online safety, problem solving, cloud computing, artificial intelligence, blockchain technology and collaboration digital skills were among digital skills needed by undergraduates to functions effectively in the labour market in Fourth Industrial Revolution (41R). These findings were in support to Apata et al. (2025) who found that students nowadays need AI skills, cloud computing skills, online safety skills as well as digital marketing skills for them to sustain their employment sustainability in the labour market. Sunday et al. (2024) found that integrating fourth industrial revolution technologies such as artificial intelligence and internet service into the academic programmes and research activities of the Akwa Ibom State University would enhance service delivery, thereby enhancing undergraduate’s digital skills development.

Finally, research question 2 showed that there was a positive relationship between Fourth Industrial Revolution (41R) and digital skills acquisition among undergraduates in Ogun State. These findings were in support to Abdullahi et al. (2022) found that despite the issues facing 4IR, it revealed a



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positive relationship with digital skills development. Alenezi (2024) revealed that insufficient support and training were identified as the primary obstacles to AI tool use in Blackboard among faculty members. Additionally, factors such as gender and educational level influenced the adoption of AI tools, highlighting various challenges in integration. Adio (2022) findings from the research revealed that utilization of 4th IR devices is low; level of awareness towards the utilization of 4th IR devices is low; Test of Hypothesis with Pearson Product Movement Correlation Coefficient (PPMC) revealed a significant positive relationship between awareness and utilization of Fourth Industrial Revolution devices at ($r=0.655$; $N=98$; $P<0.05$). Moreover, the findings showed that majority of the respondent preference to enhancement of productivity as the major benefit adopted for the utilization of 4th IR devices. Okebiorun (2020) study showed that; the Nigeria universities education is prepared for the fourth industrial revolution and further revealed that life-wide learning is suitable and flexible in empowering individual student to acquire all the knowledge and skills needed for the 4IR. The study concluded that lifelong and life-wide learning are the keys that give access to the 4IR.

Conclusion

This study leveraging on the fourth- industrial-revolution on digital skills acquisition among undergraduate students in Tai-Solarin University of Education, Ogun State; the following conclusions were drawn based on the findings of the study that coding, data analytics, data literacy, digital marketing, online safety, problem solving, cloud computing, artificial intelligence, blockchain technology and collaboration digital skills were among digital skills needed by undergraduates to functions effectively in the labour market in Fourth Industrial Revolution and that there was a positive relationship between Fourth Industrial Revolution (4IR) and digital skills acquisition among undergraduates in Ogun State.

Recommendations

The following recommendations were raised in line with the findings of the study:

1. The management of public University should incorporate artificial intelligence (AI) and internet services technologies into its system to aid the development of digital skills in undergraduates.
2. Targeted training programs and enhanced institutional support, improved internet access and AI tool subscriptions to strengthen teaching and learning. The insights inform capacity-building strategies in specialized Nigerian universities.
3. It was recommended that lecturers should possess unique technological skills to teach effectively in line with revolution from the Fourth Industrial Revolution (4IR). The 4IR on higher education are not mere talk, but a reality that university must embrace to remain relevant in the rapidly changing technological environment.
4. The curriculum must be updated to incorporate emerging technologies, innovative teaching and learning, and assessment methods. Finally, university must provide their lecturers with the necessary skills to adapt to the 4IR.
5. Undergraduates should be encouraged to be lifelong and life-wide learners to develop the capabilities needed in ever changing world.

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Effects Of Touchmath Multisensory Program on Addition and Subtraction Skills Among Selected Public School Pupils In Uyo, Akwa Ibom State, Nigeria

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Abstract

The study examined the effect of the TouchMath multisensory program on addition and subtraction skills of primary two pupils in mathematics in selected public schools in Uyo, Akwa Ibom State Nigeria. Guided by three research questions and three hypotheses, the study employed a quasi-experimental pretest-posttest nonequivalent group design. A sample of 120 pupils from six intact classes was selected through simple random sampling. The Mathematical Computational Skills Achievement Test (MCSAT), validated by experts, was used for data collection, with a reliability coefficient of 0.91 determined using Kuder Richardson Formula 20. Mean and standard deviation were used to answer research questions, while ANCOVA tested hypotheses at a 0.05 significance level. Findings revealed a significant difference in addition and subtraction skills between pupils taught with the TouchMath program and those taught conventionally. However, no significant gender-based differences were found in skills when using TouchMath. The study recommends adopting the TouchMath multisensory program for teaching mathematics in lower basic education to enhance computational skills.

Keyword: Computational Skills, Addition, Subtraction, Mathematics, Touchmath Multisensory Program, Pupils achievement

Introduction

Mathematics is a core subject in Nigeria's primary and secondary education, vital for acquiring skills in science, technology, and nation-building (Ibok & Unoh, 2019). It is essential for daily life, enabling intelligent and efficient functioning across various sectors (Ibok et al., 2019). Mathematics is globally recognized as crucial for developing skills applicable to diverse fields (Ukwueze et al., 2024). Proficiency in basic operations—addition, subtraction, multiplication, and division—underpins scientific reasoning and subjects like physics and chemistry (Okoye, 2021). However, many pupils find mathematics challenging, with high failure rates in the first school leaving certificate examination, raising concerns among researchers and stakeholders about early skill development (Ukwueze, 2024). Basic mathematical skills, including analyzing, problem-solving, addition, subtraction, fractions, and decimals, are taught in primary schools (Hayes, 2005). Primary education, the foundation of formal learning, prepares students for higher academic pursuits (Asodike & Ikpitibo, 2014; Anero, 2014). A strong primary education supports vocational and technical skills acquired later (Mba, 2019). Yet, many children face content beyond their cognitive capacity, leading to long-term deficiencies (Okoye, 2021). Success at secondary and tertiary levels depends on the foundation laid in primary years, prompting many nations, including Nigeria, to make primary education free and compulsory (National Policy on Education, 2013). In lower primary classes, basic mathematical concepts are introduced to support advanced applications in upper primary levels. The National Policy on Education (2013) defines primary education as education for children aged 6–12, aiming to foster permanent literacy, numeracy, critical thinking, and life-



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manipulative skills. The four fundamental operations—addition, subtraction, multiplication, and division—are key concepts taught at this level (Tessema, 2018). Proficiency in these skills enables students to solve complex problems. This study focuses on addition and subtraction skills, as many pupils lack proficiency due to poor teaching methods that present mathematics as abstract and difficult (Ukwueze, 2024). Studies support manipulatives as an effective method for teaching mathematics, with students using manipulatives outperforming those who do not (Alolga & Essel, 2021; Amo-Asante & Bangah, 2023). Items known as manipulatives can be touched, moved, rearranged, and in other ways handled by kids, promoting pupils' achievement in the classroom (Amo-Asante & Bonyah, 2023). Manipulatives, both physical and digital, engage multiple senses (Johnson-Smith, 2022). The National Council of Supervisors of Mathematics (NCSM) states that using tangible and digital manipulatives in lesson plans raises student achievement (Berger, Mackenzie, and Holmes, 2020; Moore, 2014). Despite these findings, pupils in lower primary classes struggle with computational skills, necessitating innovative teaching strategies.

This study investigates the efficacy of the TouchMath multisensory program in teaching addition and subtraction to primary two pupils in Uyo Local Government Area, Akwa Ibom State. TouchMath requires students to use specific points on numerals to add correctly and quickly, engaging visual, tactile, and kinesthetic senses (TouchMath.com, 2014; Bergman, 2014). Research supports TouchMath's effectiveness in improving cardinality, operational algorithms, conceptual understanding, fluency, automaticity, and modeling (Yikmus, 2016). Good mathematics teachers typically use visuals, manipulatives, and motion to enhance students' understanding of math concepts (Boaler, 2018). TouchMath bridges concrete and representational mathematics, addressing pupils' academic and cognitive needs (Yikmus, 2016). No studies on TouchMath have been conducted in Uyo, and this research incorporates gender as a variable. Gender disparities in mathematics performance are a concern, with boys often outperforming girls (Ajai & Imoko, 2015; Kabote, Niboye, and Nombo, 2014). Young children develop implicit gender stereotypes by age six, with girls perceiving boys as more capable in mathematics (Galdi, Cadinu, and Tomasetto, 2014). In Nigeria, cultural factors exacerbate gender inequalities in education, though male superiority in problem-solving is not universal (Abubakar & Adegboyega, 2012). A learner-centered, gender-responsive pedagogy like TouchMath may reduce disparities (Mwakabenga & Komba, 2021). Given the limitations of conventional teaching methods, which fail to engage pupils effectively, this study examines the effect of the TouchMath multisensory program on addition and subtraction skills of primary two pupils in selected public schools in Uyo Local Government Area, aiming to address challenges in mathematics education and gender disparities.

Statement of The Problem

Despite its importance, primary school pupils in Nigeria consistently fail mathematics massively, especially in basic computational skills. By Primary Two and Three, many lack fluency in addition and subtraction—the very foundation required for further learning. This persistent failure stems from ineffective conventional teaching methods that are abstract, teacher-centered, unengaging, and fail to use multisensory or hands-on approaches suitable for young learners. These methods also ignore gender differences in learning preferences, with boys favoring direct instruction and girls performing better in interactive, cooperative settings. Although the need for more effective, engaging, and inclusive strategies is evident, there is little research in Nigeria—particularly in Akwa Ibom State—on the use of multisensory programs like TouchMath to build early computational fluency.



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This study fills that gap by examining the effect of the TouchMath Multisensory Program on the mathematical computational skills of Primary Two pupils in selected public schools in Uyo Local Government Area.

Objectives of the study

The general objective of this study is to examine the effect of TouchMath Multisensory program on addition and subtraction skills among selected public schools in Uyo, Akwa Ibom State Nigeria. Specifically, the objective of the study is;

1. To determine the mean achievement scores of pupils taught addition computation skills using Touch-Math-Multisensory program and those exposed to lecture teaching method in Uyo, Akwa Ibom State.
2. To determine mean achievement scores of pupils taught subtraction computation skills using Touch-Math-Multisensory program and those exposed to lecture teaching method in Uyo, Akwa Ibom State.
3. To determine mean achievement scores of male and female pupils taught addition computation skills using Touch-Math-Multisensory program in Uyo, Akwa Ibom State.

Research Questions

The study was guided by the following research questions.

1. What is the mean achievement scores of pupils taught addition computation skills using Touch-Math-Multisensory program and those exposed to lecture teaching method in Uyo, Akwa Ibom State?
2. What is the mean achievement scores of pupils taught subtraction computation skills using Touch-Math-Multisensory program and those exposed to lecture teaching method in Uyo, Akwa Ibom State?
3. What is the mean achievement scores of male and female pupils taught addition computation skills using Touch-Math-Multisensory program in Uyo, Akwa Ibom State?

Hypotheses

The following hypotheses guided the study.

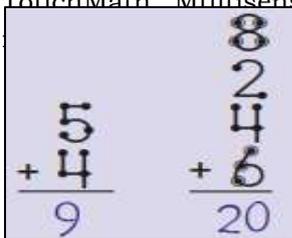
1. There is no significant difference in mean achievement scores of pupils taught addition computation skills using Touch-Math-Multisensory program and those exposed to lecture teaching method in Uyo, Akwa Ibom State
2. There is no significant difference in mean achievement scores of pupils taught subtraction computation skills using Touch-Math-Multisensory program and those exposed to lecture teaching method in Uyo, Akwa Ibom State
3. There is no significant difference in mean achievement scores of male and female pupils taught addition computation skills using Touch-Math-Multisensory program in Uyo, Akwa Ibom State

Methodology

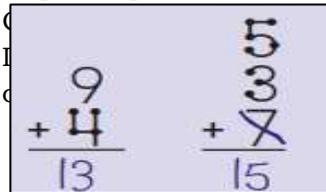
Ethical consideration Permission was granted by the ethical committee of the University of Uyo, Uyo Akwa Ibom State to conduct this study. This study adopted quasi-experimental research specifically, pretest-post-test non-equivalent control group design. According to Ezech (2015), a quasi-experimental design is one in which random assignment of subjects to treatment and control groups is not possible, but rather intact classes were used as experimental and control groups. The population comprised 11,180 primary two pupils (M=5361; F=5819) from 47 public schools in Uyo, Akwa Ibom State. A sample of 120 pupils (M=50; F=70) from six intact classes in six schools—67 in the experimental group (M=32; F=35) and 53 in the control group (M=18; F=35)—was selected via random sampling. The Mathematical Computational Skills Achievement Test (MCSAT), developed by

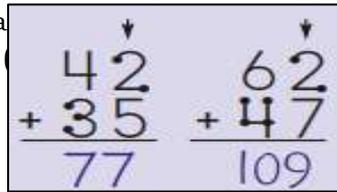
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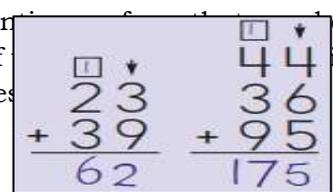
the researcher, included Section A for personal data and Section B with 20 mathematics questions. MCSAT was validated by experts from the Early Childhood and Special Education Department, a primary two teacher, and a head teacher. A pilot test on 24 equivalent pupils yielded a Kuder Richardson formula 20 reliability coefficient of 0.91. Lesson plans served as treatment packages. Permission was obtained from head teachers of sampled schools via introductory letters. Five trained research assistants upheld voluntary and informed consent. MCSAT was administered as a pretest to both groups. The experimental group was taught two-digit addition and subtraction using the TouchMath Multisensory Program. Week one focused on prerequisites: counting, numeral recognition of two-digit numbers, with pupils touching points on numerals for mastery. Week two focused on addition.



Beginning Addition







Addition without Regrouping Addition with Continuance Counting Addition with Regrouping

Week three starts with subtraction: the prerequisite to TouchMath subtraction is backward counting. Students should be able to count backward on the number line from 18. For example, using the

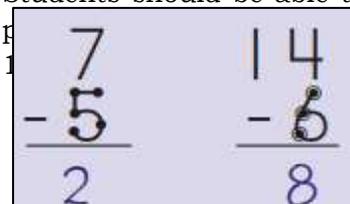


Figure 9
Subtraction Without Regrouping

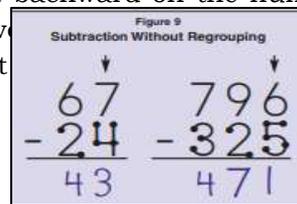
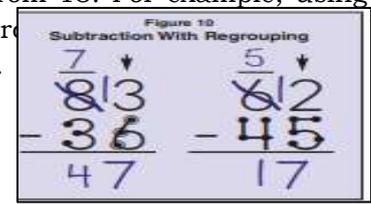


Figure 10
Subtraction With Regrouping



Beginning Subtraction Subtraction without Regrouping. Subtraction with Regrouping

Week four consolidated the study with a revision class. Research assistants used lesson plans as a guide for the treatment packages. The control group received the Talk and Chalk method. The treatment lasted four weeks. The Mathematical Computational Skills Achievement Test (MCSAT) was administered as a posttest to both experimental and control groups. SPSS version 20 calculated the mean and standard deviation for research questions. ANCOVA tested hypotheses at a 0.05



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significance level, using pretest scores as covariates for posttest scores. ANCOVA controlled extraneous variables, adjusted for non-randomized groups, ensured equivalent groups with intact classes, and highlighted initial group differences.

Presentation of Results

Participants' Bio-data Variables Category Experimental Group 67 (Males=32; Females=35) and Control Group 53 (Males=18; Females=35)

Research Question 1: What is the mean achievement scores of pupils taught addition computation skills using Touch-Math-Multisensory program and those exposed to lecture teaching method in Uyo, Akwa Ibom State?

Table 1: Mean Standard Deviation and mean difference in the addition achievement of pupils taught with TouchMath multisensory program and those taught with conventional teaching method

Groups	n	Pre-test SD	Post-test SD	Mean Difference
TouchMath Multisensory Program	67	2.10	1.18	2.94 1.19 0,84
Conventional Teaching Method	53	1.81	0.92	1.83 1.06 0.02

Table 1 shows the experimental group (TouchMath) with pretest/posttest means of 2.10/2.94 (SD 1.18/1.19) and control group (conventional) with 1.81/1.83 (SD 0.92/1.06). Mean differences indicate better addition achievement for TouchMath pupils.

Hypothesis 1

There is no significant difference in mean achievement scores of pupils taught addition computation skills using Touch-Math-Multisensory program and those exposed to lecture teaching method in Uyo, Akwa Ibom State

Table 2: Result of Analysis of Covariance (ANCOVA) of the significant difference in the in the addition achievement of pupils taught with TouchMath multisensory program and those taught with conventional teaching method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	46.899 ^a	2	23.450	19.213	.000
Intercept	92.991	1	92.991	76.190	.000
Pretest	10.432	1	10.432	8.547	.004
Methods of teaching	30.761	1	30.761	25.203	.000
Error	142.801	117	1.221		
Total	910.000	120			
Corrected Total	189.700	119			

a. R Squared = .247 (Adjusted R Squared = .234)

Table 2 reveals an F-ratio of 25.203 (p = 0.000) for the difference in addition achievement between pupils taught with the TouchMath multisensory program and those taught conventionally. Since p < 0.05, null hypothesis 1, stating no significant difference, was rejected, indicating a significant improvement in addition achievement with TouchMath.

Research Question 2: What is the mean achievement scores of pupils taught subtraction computation skills using Touch-Math-Multisensory program and those exposed to lecture teaching method in Uyo, Akwaibom State?

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Table 3: Mean Standard Deviation and mean difference in the subtraction achievement of pupils taught with TouchMath multisensory program and those taught with conventional teaching method

Groups	n	Pre-test		Post-test		Mean Difference
		SD	SD	SD	SD	
TouchMath Multisensory Program	67	1.46	1.34	2.22	1.46	0.76
Conventional Teaching Method	53	1.35	1.21	1.54	1.20	0.19

Table 3 shows the experimental group (TouchMath) with pretest/posttest means of 1.46/2.22 (SD 1.34/1.46) and control group (conventional) with 1.35/1.54 (SD 1.21/1.20). Mean differences indicate better subtraction achievement for TouchMath pupils.

Hypothesis 2

There is no significant difference in mean achievement scores of pupils taught addition computation skills using Touch-Math-Multisensory program and those exposed to lecture teaching method in Uyo, Akwa Ibom State

Table 4: Result of Analysis of Covariance (ANCOVA) of the significant difference in the subtraction achievement of pupils taught with TouchMath multisensory program and those taught with conventional teaching method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	16.931 ^a	2	8.466	4.642	.011
Intercept	154.826	1	154.826	84.888	.000
Pretest	3.380	1	3.380	1.853	.176
Methods of teaching	12.986	1	12.986	7.120	.009
Error	213.394	117	1.824		
Total	675.000	120			
Corrected Total	230.325	119			

a. R Squared = .074 (Adjusted R Squared = .058)

Table 4 shows an F-ratio of 7.120 (p = 0.009) for subtraction achievement differences between TouchMath and conventional teaching groups. As p < 0.05, null hypothesis 2, claiming no significant difference, was rejected, confirming superior subtraction achievement with TouchMath.

Research Question 3:What is the mean achievement scores of male and female pupils taught addition computation skills using Touch-Math-Multisensory program in Uyo, Akwa Ibom State?

Table 5:Mean Standard Deviation and mean difference in the addition and subtraction skills of boys and girls taught with TouchMath Multisensory Program

Gender	N	Pre-test		Post-test		Mean Difference
		SD	SD	SD	SD	
Boys	32	7.65	4.89	12.08	4.41	4.43
Girls	35	9.00	4.00	13.12	3.39	4.12

Table 5 shows boys' pretest/posttest means of 7.65/12.08 (SD 4.89/4.41) and girls' means of 9.00/13.12 (SD 4.00/3.39) using TouchMath. Boys' mean difference (4.43) slightly exceeds girls' (4.12), indicating both benefited from the TouchMath multisensory program.

Hypothesis 3



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There is no significant difference in mean achievement scores of male and female pupils taught addition computation skills using Touch-Math-Multisensory program in Uyo, Akwaibom State

Table 6:Result of Analysis of Covariance (ANCOVA) of the significant difference in the addition and subtraction skills achievement of boys and girls taught with TouchMath Multisensory Program

Source	Type Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	318.249	2	159.125	14.143	.000
Intercept	1097.865	1	1097.865	97.581	.000
Pretest	300.193	1	300.193	26.682	.000
Methodsof teaching	2.581	1	2.581	.229	.634
Error	720.049	64	11.251		
Total	11645.000	67			
Corrected Total	1038.299	66			

a. R Squared = .307 (Adjusted R Squared = .285)

Table 6 reports an F-ratio of 0.229 ($p = 0.634$) for the difference in mathematics computational skills achievement between boys and girls taught with the TouchMath Multisensory Program. Since $p > 0.05$, null hypothesis 3, stating no significant difference, was accepted, indicating no gender-based difference in achievement.

Discussion of Findings

The study found that pupils taught with the TouchMath Multisensory Program outperformed those taught with the conventional method in addition achievement, with a significant difference in performance. This aligns with Calik (2010), who found that touch math techniques based on direct instruction effectively teach basic summation skills to students with mild intellectual disabilities. Similarly, Amaal Ahmed Mostafa (2013) reported the effectiveness of the TouchMath program in enhancing addition skills among target children. Yıkmış (2016) also found the touch math technique effective, with all participants showing improved addition skills by the end of teaching sessions compared to baseline, supporting the technique’s generalizability and maintenance.

Pupils taught with TouchMath also performed better in subtraction achievement than those taught conventionally, with a significant difference in outcomes. This concurs with Abdallah (2020), who found higher post-test mean scores in addition and subtraction for the experimental group using the TouchMath multisensory program, indicating its effectiveness for young children at risk for computation skill acquisition. This finding supports Jerome Bruner’s (1966) theory that mental development progresses through concrete, pictorial, and symbolic stages, with early learning enhanced by manipulative activities. The study revealed that pupils taught with TouchMath outperformed those taught conventionally in multiplication achievement, with a significant difference in performance. This agrees with Khalifa and Saad (2021), who found that TouchMath positively impacts early mathematics ability in kindergarten children with mild to borderline intellectual functioning and their typically developing peers in inclusive classrooms, proving effective, sustainable, and generalizable. Ullrich (2014) also found that TouchMath instruction improved students’ ability to add quickly and accurately, regardless of gender, language, or attendance.

No significant gender differences were found in mathematics computational skills achievement among pupils taught with TouchMath, despite boys showing a slightly higher mean difference. This



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supports Kashefi et al. (2018), who found no significant gender differences in mathematics performance in higher-order thinking skills among grade four Malaysian international school students. However, this contrasts with Oribhabor (2020), who found significant gender differences favoring males among senior secondary students in Bayelsa State, and Anjum (2015), who reported differences in mathematics achievement between boys and girls at the upper primary stage. Similarly, no significant gender differences were found in addition and subtraction achievement among pupils taught with TouchMath, despite boys' slightly higher mean difference. This aligns with Kashefi et al. (2018) but contrasts with Oribhabor (2020) and Anjum (2015), who found significant gender differences favoring males.

Limitations included head teachers' reluctance to allow the experimental study and financial constraints for purchasing TouchMath kits. These were overcome by securing permission with an introductory letter and improvising teaching aids. As no prior study in Uyo Local Government Area examined TouchMath, this research contributes to knowledge by demonstrating its effectiveness in improving addition and subtraction skills and adding to literature on computational skills and classroom practices. Since no study explored TouchMath and multiplication achievement, this study highlights its potential in this area. The study focused only on addition and subtraction skills. Further research should investigate other computational skills, such as multiplication and division of two- and three-digit numbers.

Conclusion

Based on the findings of this study, it was concluded that TouchMath Multisensory Program has a significant effect on mathematical computational skills of pupils in Uyo Local Government Area of Akwa Ibom State. There is no significant gender difference on mathematical computational skills that is counting, addition, subtraction and multiplication.

Recommendations

Based on the conclusion of the study the following recommendations were made:

1. The study found the use of TouchMath Multisensory Program effective in enhancing meaningful learning in mathematical addition and subtraction skills, thus teachers should be encouraged to use TouchMath Multisensory Program in teaching addition and subtraction skills.
2. The State Ministry of Education should provide instructional materials, which are needed for the implementation of TouchMath Multisensory Program as a method of teaching
3. Both the State and the Federal Government should organize workshops, seminars and for primary teachers on how to use TouchMath Multisensory Program in the teaching and learning process.

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Analysis of Aeromagnetic Data of North-Eastern Part of Sokoto Basin for Identification of Geological Structures in Sokoto State, Nigeria

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Abstract

This study centers on investigating the subsurface condition of the north-eastern part of the Sokoto Basin using aeromagnetic data for geological structures. This area falls within the Sokoto Basin, the Nigerian portion of the Iullemeden Basin, and covers four adjacent quarter-degree sheets of Gada, Sabon Birnin, Rabah, and Isa. Qualitative and quantitative interpretation techniques which include First and Second Vertical Derivatives, Upward Continuation, Analytic Signal, Source Parameter Imaging, and Euler Deconvolution were employed. The first and second vertical derivatives applied show the response of the target structures, which helps to remove noise caused by high-frequency shallow anomalies. The analytic signal map shows high analytic signal amplitude most prominently around the east-west flank, with low analytic signal value towards the centre, with amplitude ranging from 0.00 nT to 0.08 nT. The data was subjected to upward continuation at 2 km, 5 km, 10 km, and 15 km with magnetic field values ranging from 7.25 nT to 84.27 nT, 17.73 nT to 74.46 nT, 22.17 nT to 68.86 nT, and 23.83 nT to 67.12 nT, respectively. The result shows the magnetic anomaly for deep-seated features becomes more obvious by projecting from a lower elevation to a higher elevation, thereby removing noise caused by high-frequency shallow anomalies.

Key words: Geological structures, Aeromagnetic data, Sokoto basin, Iullemeden basin.

Introduction

The contents of the Earth have long been of concern to mankind. Man has tried to unravel its complexity and delve into its origin through various geophysical methods. Particularly the subsurface has been of great concern to geoscientists, who seek to investigate it using diverse means, some for the purpose of knowledge, while others do it for the exploration of economic resources such as minerals and hydrocarbons. Economic minerals, such as oil, gas, and groundwater lie concealed



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beneath the earth's surface, thus hidden from direct view (Bonde *et al.*, 2014). Depth to basement is a germane exploration parameter particularly for areas where there may be mature hydrocarbons. Geologists and Geophysicists have done extensive work in terms of geological mapping of Nigeria. They have worked on the interpretation of aeromagnetic data obtained mainly from restricted areas of their studies (Emujakporue and Ofoha, 2015). Depth to anomalous magnetic source interpretation provides a clue to the sedimentary basin architecture for hydrocarbon exploration as well as the presence of minerals (Onyewuchi and Ugwu, 2017). The magnetic method is one of the oldest geophysical techniques used to delineate subsurface structures and determine the source of specific anomalies present in an area under investigation (Reeves, 2007). Minerals are of importance to the economy of a nation if discovered and harnessed. As this will create a productive environment for business opportunities, boost the nation's economy, and provide raw materials for industrial uses which might in turn reduce the level of unemployment, thereby eradicating poverty in the country. It is therefore necessary to carry out research of this magnitude using high-resolution aeromagnetic (HRAM) data. Exploitation of mineral resources has assumed prime importance in several developing countries including Nigeria. Nigeria is endowed with abundant mineral resources, which have contributed immensely to the national wealth with associated socio-economic benefits. Mineral resources are an important source of wealth for a nation but before they are harnessed, they have to pass through the stages of exploration, mining, and processing (Adewumi and Salako, 2017).

In a related development, Mukhtar and Congjiao (2012) stated that Nigeria has seven (7) basins in which active exploration activities can be carried out and these basins include the following; Anambra Basin, Benue Trough, Benin Basin, Bida Basin, Bornu Basin, Niger Delta Basin, and Sokoto Basin.

Objective of the Study

The objective of this study is to analyze aeromagnetic data from the north-eastern part of the Sokoto Basin to identify geological structures, such as faults, fractures, and lineaments that may be indicatives of mineralization.

Research Question

1. What are the dominants structural trends and lineaments in the north-eastern part of the Sokoto Basin?
2. Can aeromagnetic data be used to identify potential mineralized zones in the study area?

Research Hypotheses

1. The north-eastern part of the Sokoto Basin has significant geological structures, such as faults and fractures that are indicative of mineralization.
2. Aeromagnetic data can be used to identify and characterize these geological structures, providing valuable insights for further exploration and research.

Location of the Study Area

This study area lies between longitude 005° E to 006° E and latitude 13° 00' N to 13.5°N. It is made up of four (4) sheets which include; Gada (sheet 4), Sabon Birnin (sheet 5), Rabah (sheet 11), and Isa (sheet 12) respectively. The Sokoto sedimentary basin is located in the North-Western part of Nigeria; it is situated along the longitude 3° 30' E to 7° 00' E and latitude 10° 30' N to 14° 00' N, with an approximate area of 59,570 km². The Sokoto Basin is also known as the Iullemeden Basin, with an average elevation varying from 250 m to 400 m above sea level (Ofoha *et al.*, 2016).



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Materials and Methods

Materials

The software and data used in the course of this research work include various geophysical software such as Geosoft Oasis Montaj (v7.2), Golden Software Surfer 13, Golden Software Grapher 8, and MATLAB. The aeromagnetic data was acquired from the Nigerian Geological Survey Agency (NGSA).

Methods

As the aircraft flies, the magnetometer records tiny variations in the intensity of the ambient magnetic field due to the temporal effects of the constantly varying solar wind and spatial variations in the Earth's magnetic field, the latter being due both to the regional magnetic field and the local effect of magnetic minerals in the Earth's crust. By subtracting the solar and regional effects, the resulting aeromagnetic map shows the spatial distribution and relative abundance of magnetic minerals (most commonly the iron oxide mineral magnetite) in the upper levels of the crust. Because different rock types differ in their content of magnetic minerals, the magnetic map allows a visualization of the geological features of the upper crust in the subsurface, particularly the spatial geometry of bodies of rock and the presence of structures such as faults and folds. The raw total magnetic intensity data acquired from the Nigerian Geological Survey Agency was processed using Golden Software Surfer and Geosoft Oasis Montaj. The acquired total magnetic intensity data was converted into a grid file and imported into the Oasis Montaj database for processing. Enhancement of magnetic data is very important in the study of structural features because it enhances the edges of anomalies. The first vertical derivative, second vertical derivative, and analytical signal were used in this research to enhance the upward continued field data. Enhanced potential field anomalies are primarily used in qualitative visual analysis to infer the approximate shape and orientations of anomalous sources of interest which may be localized features at relatively shallow depths, or large-scale structures at greater depth (Sharma, 2002).

Detection of the edges of geological structures from the analysis of potential field data is commonly performed. The horizontal gradient of a field ϕ sampled at locations Δx intervals along a profile may be calculated in the space domain as:

$$\frac{d\phi}{dx} = \frac{\phi_{x+\Delta x} - \phi}{\Delta x}, \quad 1$$

or in the frequency domain (Gunn, 1975)

$$A'(f) = A(f)(if)^n \quad 2$$

where $A(f)$ is the amplitude at a frequency f , i is the complex number and n is the order of the derivative. The gradient profiles, being narrower in width, clearly show the body location more precisely than do the original data, but since derivatives are high-pass filters they also amplify any noise present in the data.

Vertical Derivative Filters

The vertical derivative is applied to total magnetic field data to enhance the most shallow geological sources and it can be calculated in either the space or the frequency domain. The enhancement sharpens anomalies over bodies and tends to reduce their complexity, allowing a clearer imaging of a causing structure. The transformation can be noisy since it will amplify short-wavelength noise. Vertical gradients of potential fields are also a mainstay of the interpretation process, principally because they sharpen the response of geophysical features. This filtering method is effective in



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enhancing anomalies due to shallow sources; it narrows the width of anomalies and is also very effective in locating source bodies more accurately (Cooper and Cowan, 2004). In the frequency domain, they can be calculated using (Gunn, 1975):

$$A'(f) = A(f)|f|^n \quad 3$$

where A(f) is the amplitude at a frequency f, and n is the order of the derivative.

Vertical derivatives are a measure of curvature, and large curvatures are associated with shallow anomalies. Thus, it enhances near-surface features at the expense of deeper anomalies. The first and second vertical derivatives (FVD & SVD) are given as:

$$FVD = \frac{\partial M}{\partial z}, \quad SVD = \frac{\partial^2 M}{\partial z^2} \quad 4$$

where M is the potential field anomaly.

The second vertical gradient can be calculated by exploiting Laplace's equation below: (Blakely, 1995)

$$\frac{\partial^2 \phi}{\partial z^2} = -\frac{\partial^2 \phi}{\partial x^2} - \frac{\partial^2 \phi}{\partial y^2} \quad 5$$

The first vertical derivative is an important step in the interpretation of aeromagnetic data, particularly in studies dealing with narrow and shallow anomalies. It reduces the effect of long-wavelength regional anomalies (which are usually deeper) and enhances the higher frequency shallow anomalies (Milligan and Gunn, 1997).

Second vertical derivative filters are used to enhance subtle anomalies while reducing regional trends. These filters are considered most useful for defining the edges of bodies and for amplifying fault trends. In mathematical terms, a vertical derivative can be shown to be a measure of the curvature of the potential field, while zero values (or contours) of second vertical derivative contours define the edge of the causative body (Telford et al., 1990). Thus, the second vertical derivative is in effect a measure of the curvature, i.e., the rate of change of non-linear magnetic gradients. The zero magnetic contours of the second vertical derivative often coincide with lithological boundaries (Blakely, 1995).

Upward Continuation of Residual Field

This is a mathematical technique that projects data taken at an elevation to a higher elevation. It is a filtering technique that removes noise caused by high-frequency (short wavelength) anomalies which usually arise from near-surface cultural features in the survey area. It accentuates anomalies caused by deep sources at the expense of anomalies caused by shallow sources (Mekonnen, 2004). The upward continued ΔF (the total field magnetic anomaly) at a higher level (z = -h) is given by:

$$\Delta F(x, y, -h) = \frac{h}{2\pi} \iint \frac{\Delta F(x, y, 0) dx dy}{((x-x_0)^2 + (y-y_0)^2 + h^2)} \quad 6$$

The empirical formula gives the field at an elevation h above the plane of the observed field (z = 0) in terms of the average value ΔF at the point (x, y, 0). Generally, deep-seated magnetic sources are considered to have a low spatial frequency equivalent to large lateral extent or long wavelengths and broad anomalies; while near-surface or shallow magnetic sources result in a high spatial frequency corresponding to short lateral distance or short wavelength and narrow anomalies (Dobrin, 1976).

The Analytic Signal Technique

This is a filter applied to magnetic data aimed at simplifying the fact that magnetic bodies usually have a positive and negative peak associated with them, which in many cases makes it difficult to determine the exact location of the causative body. The analytic signal is a complex function formed



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through a combination of the horizontal and vertical derivatives of the magnetic anomaly. In 3D, the analytic signal of the magnetic anomaly field T is defined as:

$$A(x, y, z) = \frac{\partial T}{\partial x} \hat{x} + \frac{\partial T}{\partial y} \hat{y} + i \frac{\partial T}{\partial z} \hat{z} \quad 7$$

where \hat{x} , \hat{y} and \hat{z} are unit vectors in the x, y and z directions, respectively, $\frac{\partial T}{\partial z}$ is the vertical

derivative of the magnetic anomaly field intensity, $\frac{\partial T}{\partial x}$ and $\frac{\partial T}{\partial y}$ are the horizontal derivatives of the

magnetic anomaly field intensity (Blakely, 1995).

The amplitude of the analytic signal in 3D is given by:

8

$$[A(x, y, z)] = \sqrt{\left(\frac{\partial T}{\partial x}\right)^2 + \left(\frac{\partial T}{\partial y}\right)^2 + \left(\frac{\partial T}{\partial z}\right)^2}$$

Expression of the amplitude of the analytic signal gives a function that produces maxima approximately over the edges of the magnetic body source. Their results showed that the location of the analytic signal depends on depth. When the prism is at shallow depth the locations of the maxima are essentially over both edges of the prism. The locations become shifted from edges when the top depth increases. In the 2D case, only for an infinitely thin dike and infinitely vertical step or contact, the locations of the 2D analytic signal's maxima are directly over the top surface edges of the causative body. However, for a vertical thin dike, the analytic signal's maxima are also offset away from both edges. In 3D and in general, the analytic signal amplitude is dependent on: the burial depth, extent and dipping angle of a source body, body's magnetization direction, and earth's magnetic field direction. For 2D magnetic sources, the analytic signal amplitude becomes independent of the magnetization direction.

Source Parameter Imaging (SPI)

This method makes the task of interpreting data significantly easier as shown by the SP Images generated from the residual field data. The colour legend in the SPI shows various colours that represent the depth estimates to magnetic source rock/body within the study area. This method utilizes the relationship between source depth and the local wavenumber (k) of the observed field, which can be calculated for any point within a grid of data through horizontal and vertical gradients. At peaks in the local wavenumber grid, the source depth is equal to n/k, where n depends on the assumed source geometry (analogous to the structural index in Euler deconvolution); for example, n = 1 for a contact, n = 2 for a dyke (Blakely and Simpson, 1986). The assumed geometry for each magnetic body was used to determine the area where we have shallow and deep-lying magnetic bodies in the study area. Peaks in the wavenumber grid were identified using a peak tracking algorithm and valid depth estimates were also isolated. The source parameter imaging method was also employed in this work to estimate the depth from the local wavenumber of the analytical signal. The analytical signal A(x, z) is given as (Biswas *et al.*, 2017):



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$$A_1(x, z) = \frac{\partial m(x, z)}{\partial y} - j \frac{\partial m(x, z)}{\partial x} \quad 9$$

Where $m(x, z)$ is the magnitude of the anomalous total magnetic field, j is the imaginary number, while x and z are Cartesian coordinates for the vertical and horizontal directions, respectively.

Euler Deconvolution

Any function $f(x, y, z)$ is homogeneous of degree n if

$$f(tx, ty, tz) = t^n f(x, y, z) \quad 10$$

Where t is a real number. The plane of observation is taken at plane $z = 0$ and positive downward. Moreover, if $f(x, y, z)$ is homogeneous of degree n , according to Thompson (1982) the following equation holds:

$$x \frac{\partial f}{\partial x} + y \frac{\partial f}{\partial y} + z \frac{\partial f}{\partial z} = nf \quad 11$$

This partial differential equation is known as Euler's homogeneity equation. Now, consider the total magnetic intensity of a point source located at the point (x_0, y_0, z_0) relative to the point of observation (x, y, z) :

$$\Delta T(x, y) = f[(x - x_0), (y - y_0), (z - z_0)] \quad 12$$

The above equation can be written as:

$$(x - x_0) \frac{\partial \Delta T}{\partial x} + (y - y_0) \frac{\partial \Delta T}{\partial y} + (z - z_0) \frac{\partial \Delta T}{\partial z} = n \Delta T \quad 13$$

This equation expresses the magnetic field strength at any point in terms of the gradients of the total magnetic field. These gradients are related to different magnetic sources by the structural index, N . The structural index N is a measure of the rate of change of distance of a field (Reid *et al.*, 1990). Thompson, (1982) gives more detailed discussion on the degree of homogeneity of potential fields and structural indices of Euler deconvolution.

Presentation of Results and Discussion

The results of First Vertical Derivative (FVD), Second Vertical Derivative (SVD), Upward Continuation, Analytical Signal Technique, Source Parameter Imaging (SPI), and Euler Deconvolution Technique are shown in Figure 1, Figure 2, Figure 3 (a, b, c, & d), Figure 4, Figure 5, and Figure 6 respectively.

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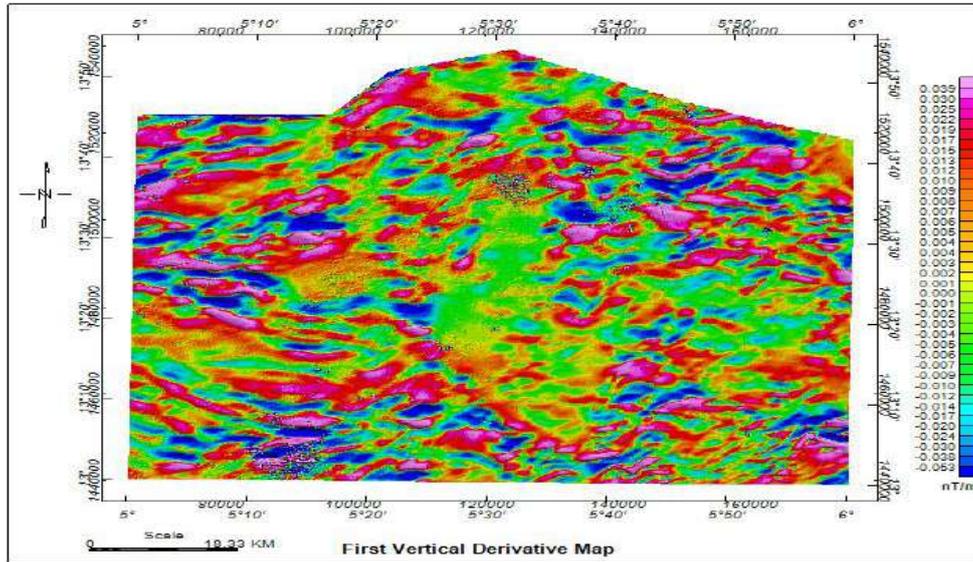
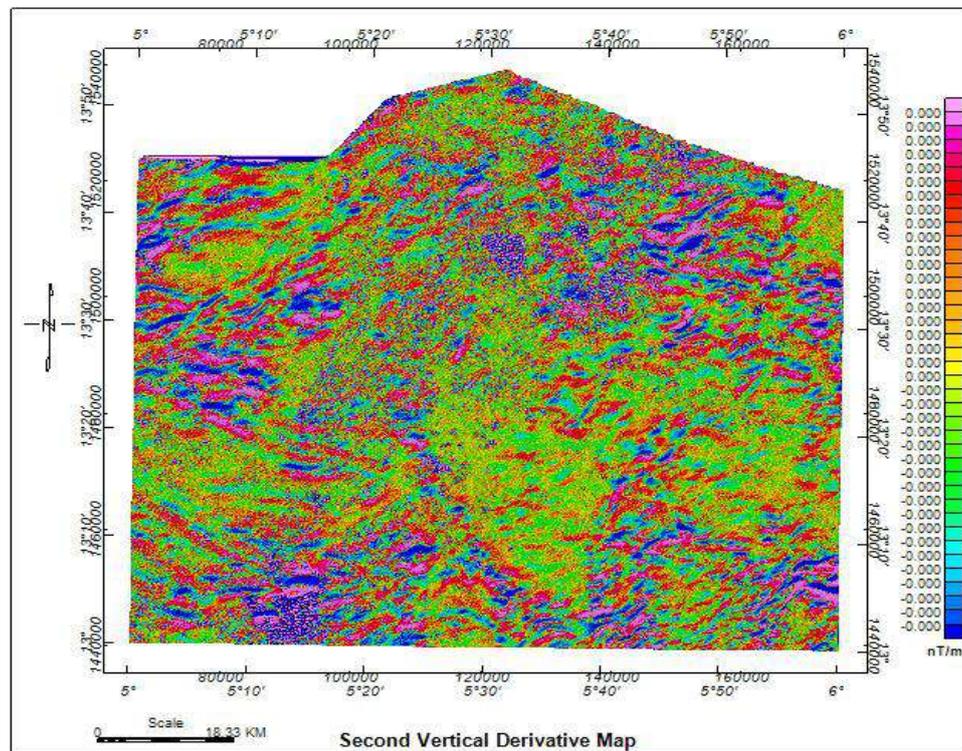


Figure 1: First Vertical Derivative Map



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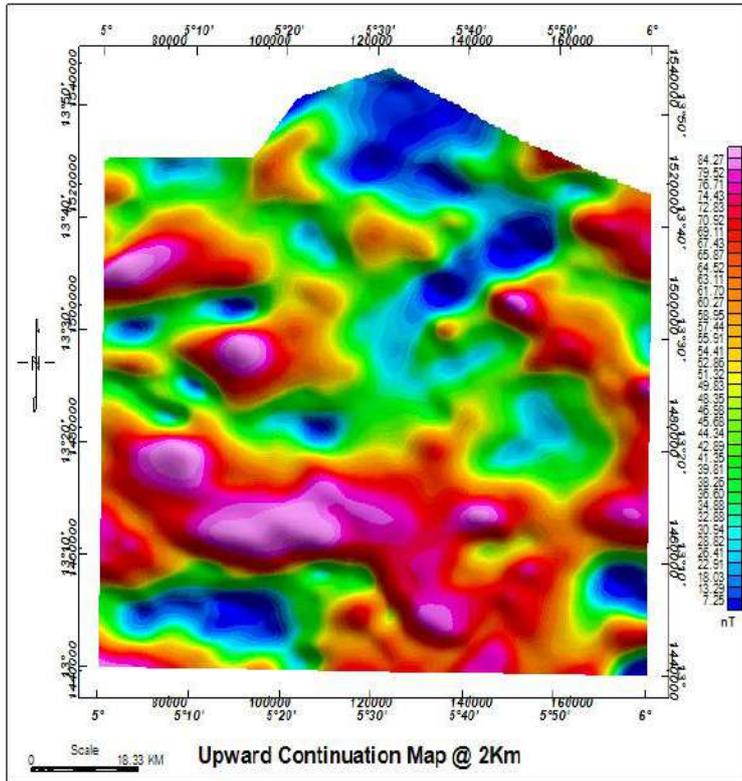


Figure 3a: Upward Continuation Map @ 2 km

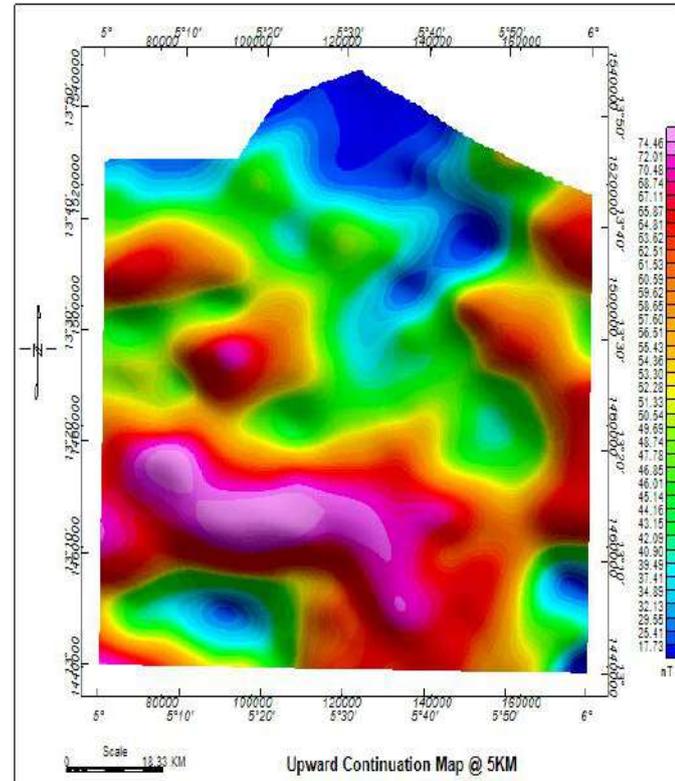


Figure 3b: Upward Continuation Map @ 5 km

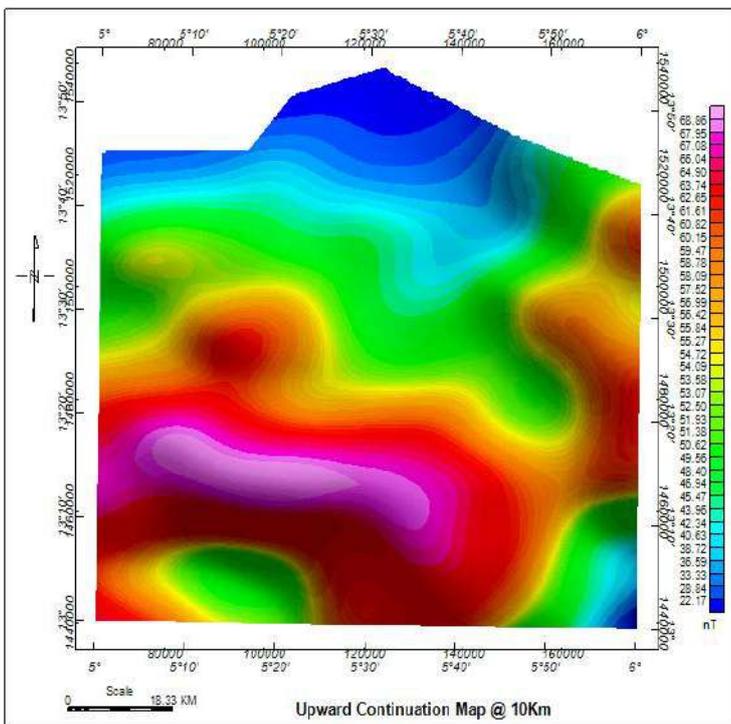


Figure 3c: Upward Continuation Map @ 10 km

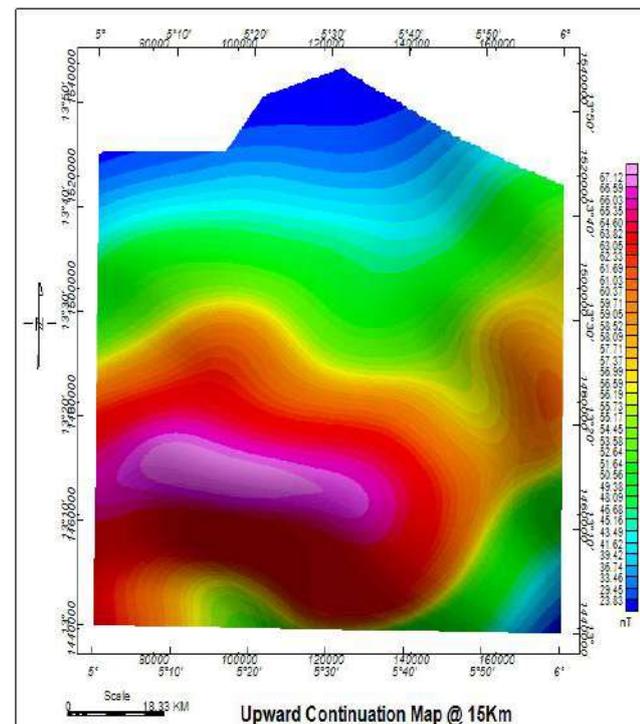


Figure 3d: Upward Continuation Map @ 15 km

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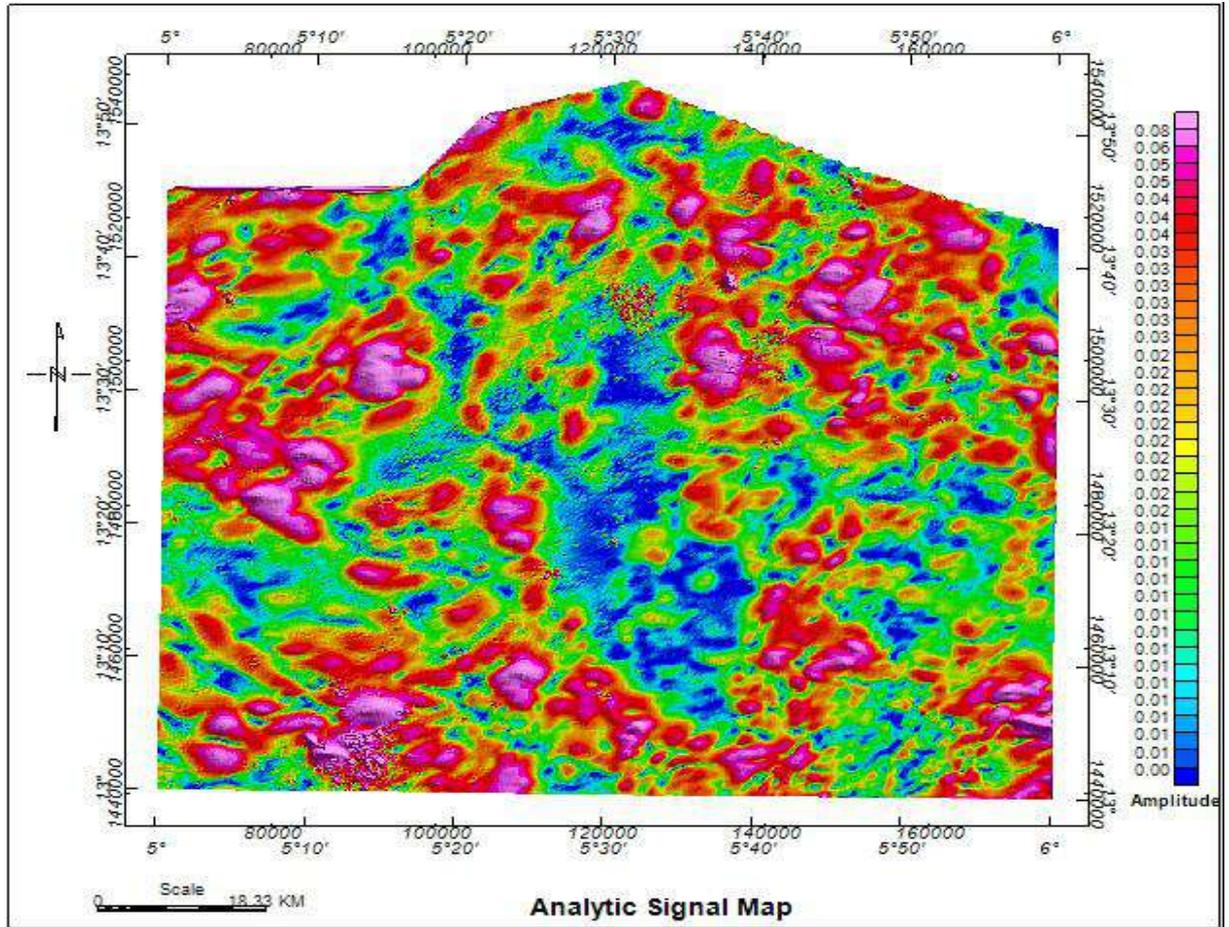
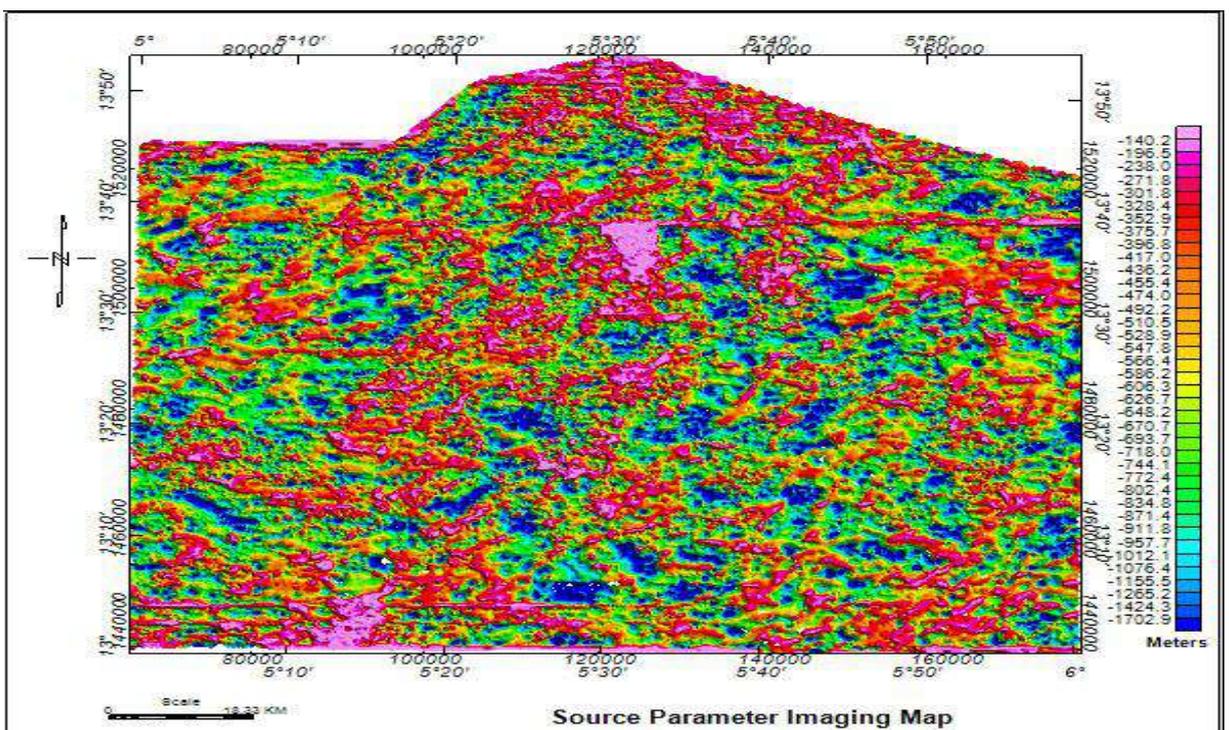


Figure 4: Analytic Signal Map



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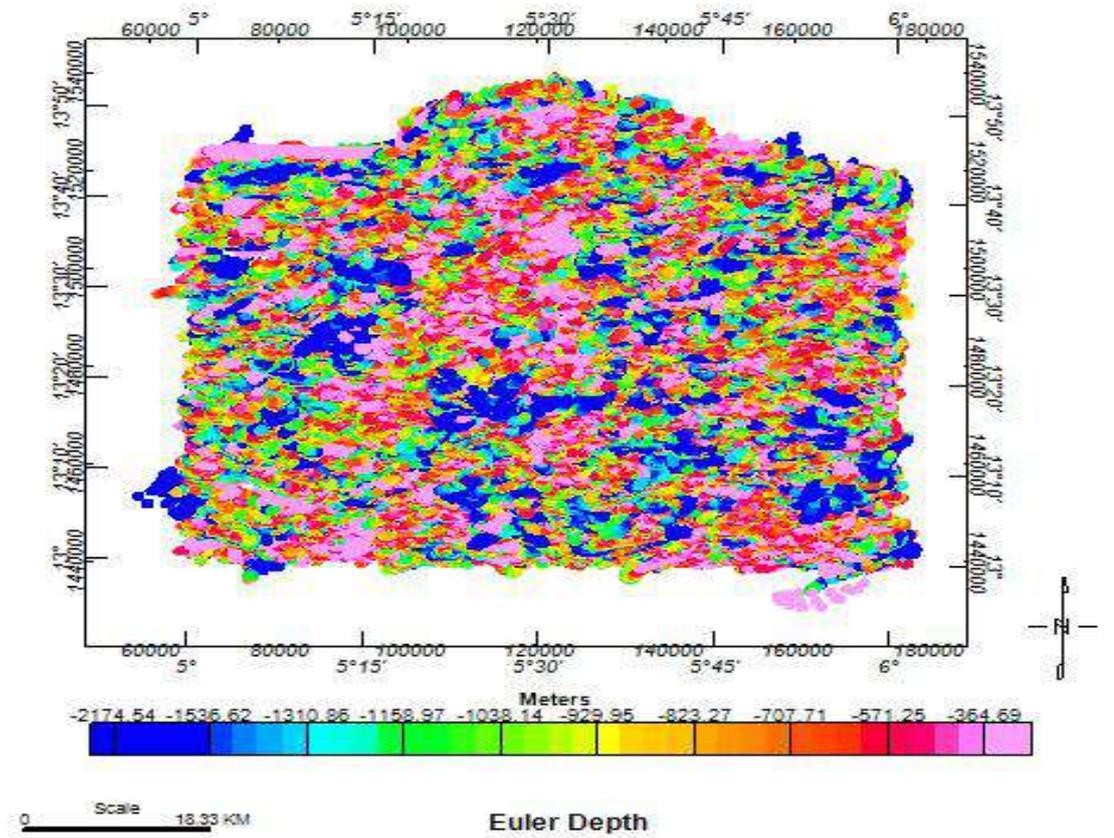


Figure 6: Euler Depth

Figure 1: First Vertical Derivative (FVD) Map. The map shows the response of the target structures, which helps remove noise caused by high-frequency shallow anomalies, with magnetic field values ranging from -0.053 nT/m to 0.039 nT/m. Several linear highs (red) and lows (blue) are evident, trending predominantly in the NE-SW and NW-SE directions. These linear features are interpreted as fault lines or shear zones within the basement complex, which likely influence the overlying sedimentary architecture.

Figure 2: Second Vertical Derivative (SVD) Map. The map shows a more enhanced view of near-surface anomalies than the FVD map, with magnetic field values ranging from -0.053 nT/m to 0.039 nT/m. It provides a much clearer view of the edges of anomalies because it sharpens them. The SVD analysis effectively discriminates local features while suppressing broad regional structures. The zero contours of the SVD (white lines) clearly delineate the boundaries of magnetic source bodies, which often correspond to lithological contacts or faults. The NE-SW structural trend remains dominant.

Figure 3: Upward Continuation Maps. (a) 2 km, (b) 5 km, (c) 10 km, (d) 15 km. The appropriation of the magnetic intensities from deeper structures led to applying the upward-continued filter to suppress the effects of shallow anomalies. The RMI grid was continued to 15 km to see deeper signatures coming from deeper structures. This helped smooth out high-frequency anomalies relative to low-frequency anomalies.

Figure 3a (2 km): Magnetic field values range from 7.25 nT to 84.27 nT. Shallow, high-frequency anomalies are still prominent.

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Figure 3b (5 km): Magnetic field values range from 17.73 nT to 74.46 nT. Regional trends begin to emerge as shallow features are attenuated.

Figure 3c (10 km): Magnetic field values range from 22.17 nT to 68.86 nT. A broad, high-amplitude anomaly in the central-southern part of the study area becomes clearly visible, suggesting a deep-seated magnetic source body.

Figure 3d (15 km): Magnetic field values range from 23.83 nT to 67.12 nT. The deep-seated anomaly persists, confirming its origin from a profound depth within the basement. These maps show the magnetic anomaly for deep-seated features more obviously by projecting field data from a lower elevation to a higher elevation.

Figure 4: Analytic Signal Amplitude Map. The map shows the analytic signal amplitude at various locations, ranging from 0.00 nT to 0.08 nT. The map shows high analytic signal amplitude (red and yellow) most prominently around the east-west flanks, with low analytic signal values (blue) towards the centre. Since the analytical amplitude is independent of magnetization direction, the high amplitudes directly indicate the locations of sharp magnetic contrasts, such as the edges of intrusive bodies, faults, or basement highs. The arcuate pattern of high amplitudes along the flanks suggests a possible basin-bounding fault system, while the central low may represent a deeper, less disturbed sedimentary section.

Figure 5: Source Parameter Imaging (SPI) Depth Estimate Map. The colour legend shows the depth estimate to the magnetic source (sediment/basement interface). The depth varies between 0.14 km and 1.7 km. The greatest sediment thickness (deepest basement) is found in the south-central to north-eastern part, which is in agreement with the work of Ofoha *et al.* (2016). However, relatively deeper areas are also scattered around the northern and southern parts. This analysis helps in edge detection, with various anomalous bodies following the trend of the residual anomalies. The SPI map effectively outlines the topography of the basement surface, showing areas prospective for deeper sedimentary accumulation.

Figure 6: Euler Deconvolution Depth Solutions. The plot shows depth solutions clustered around regions where geological structures are located. The depth solutions (calculated for a structural index appropriate for geologic contacts) have a range of approximately -0.35 km to -2.17 km (negative denoting depth below the datum). These depth values correspond to the probable locations and depths of the magnetic bodies (primarily the basement surface) in the study area. The clustering of solutions along linear trends (e.g., NE-SW) provides a quantitative confirmation of the fault systems inferred from the derivative maps. The average depth range indicates the presence of predominantly shallow-to-moderate depth features.

Synthesis of Interpretation: The integrated analysis reveals a structurally complex basement underlying the north-eastern Sokoto Basin. The dominant NE-SW and subsidiary NW-SE structural trends, identified as faults and shear zones from derivative maps and Euler solutions, compartmentalize the basin. The SPI and Euler depth estimates consistently show a basement depth generally less than 2 km, with the deepest section (~1.7 km) located in the south-central to north-eastern region. The analytic signal and upward continuation confirm the presence of deep-seated magnetic sources influencing the regional magnetic signature. This structural framework is crucial for understanding basin evolution and identifying zones where these structures might have created traps or pathways for hydrocarbons or mineralized fluids.

Conclusion

The aeromagnetic data proved valuable in the delineation of subsurface structures and estimation of basement depth in the north-eastern Sokoto Basin. The application of both qualitative and



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quantitative techniques successfully revealed a dominant NE-SW structural trend, interpreted as fault systems, and delineated the configuration of the basement topography. The sediment thickness, estimated to reach up to 1.7 km, indicates that the sediments are sufficiently deep to have undergone maturation processes if organic-rich source rocks are present. The integration of all methods provides a coherent geological model of the area, highlighting zones of structural complexity that are primary targets for further exploration for mineral and hydrocarbon resources.

Recommendation

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

1. Ground Truthing: The inferred fault systems and depth estimates should be verified with other geophysical methods, such as seismic reflection surveying or magnetotellurics, to better characterize the structures and basin geometry.
2. Detailed Geochemical Studies: Areas with identified structural features (faults, basement highs) should be investigated with detailed soil gas geochemistry or gravity surveys to assess their potential for hydrocarbon accumulation or mineral concentration.
3. Integration with Geological Data: The results of this study should be integrated with existing geological maps, well log data, and borehole information from the basin to build a more robust and calibrated geological model

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Effects of Digital Communication on ... Bala, K. & Sule, M. (2025)

Effects of Digital Communication on Segmented and Super-Segmented Features of Pronunciation Patters among Undergraduate English Language Students in Nigeria

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Abstract

The widespread use of digital communication platforms, such as instant messaging, social media, and video conferencing, has transformed how university students interact and use language. This study investigates the effects of digital communication on pronunciation patterns, with a focus on both segmental features (vowel quality and consonant articulation) and supra segmental features (stress placement, rhythm, and intonation) among undergraduate students in Nigeria. A total of sixty participants, aged 18–25, and provided speech samples through structured reading tasks, spontaneous speech, and digital voice notes. Acoustic analyses measured vowel formants, consonant precision, stress placement, and pitch variation, while perceptual analyses involved listener ratings of intelligibility and naturalness. Results indicate that frequent engagement in digital communication is associated with reduced articulation precision, weakened stress contrasts, and a narrower pitch range, particularly in spontaneous and digital speech samples. These changes negatively impact intelligibility, suggesting that informal, rapid, and text-mediated communication encourages adaptations that deviate from standard pronunciation norms. Nevertheless, exposure to varied speech contexts can mitigate some comprehension challenges. The findings have important implications for language teaching, pronunciation training, and digital literacy programmes, highlighting the need to balance informal digital speech habits with strategies that preserve clear and intelligible communication. By understanding how digital communication influences pronunciation, educators and speech professionals can better support students in maintaining effective oral communication across both online and face-to-face contexts.

Keywords: Digital communication, segmented, super-segmented features, University students,

Introduction

In the dynamic environment of university life, digital communication platforms, such as instant messaging apps, social media networks, and video-conferences, have become deeply embedded in students' everyday linguistic practices. These technologies do not simply extend traditional face-to-face interaction; they shape the very way students use language, both in writing and oral engagement. While scholarly attention has long focused on the effects of texting and online interaction on written language (Crystal, 2008; Tagliamonte & Denis, 2020), far less has been devoted to the subtler impact these forms have on spoken language, and in particular on pronunciation. Pronunciation involves more than articulating individual sounds (segmental features such as vowels and consonants); it also encompasses supra segmental features, for example, stress patterns, rhythm, intonation, and pitch variation, that play a critical role in determining how speech is perceived, understood, and processed by listeners (Ladefoged & Johnson, 2014). Alterations in any of these domains can affect intelligibility, listener comprehension, and the overall effectiveness of communication.



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Digital communication environments often encourage rapid, informal exchanges, typographically mediated messages, and compressed speech segments. These contexts may reduce opportunities for deliberate articulation and thus reinforce simplified or abbreviated speech forms (Baron, 2008; Levis, 2018). More recently, researchers have highlighted how new digital behaviors, such as voice-note usage, video clip replies, and AI-based speech tools, are associated with narrower pitch ranges, less rhythmic contrast, and transformed prosodic behaviors among learners (Ping & Tao, 2025; Liu, 2025). Within this evolving context, the present study sets out to examine how habitual use of digital communication platforms by Nigerian university students influences their pronunciation patterns. It adopts a dual focus on acoustic measures (vowel quality, consonant articulation, pitch range, syllable timing) and listener-based perceptual outcomes (intelligibility, naturalness).

Literature Review

Digital Communication and Spoken Language

The rapid expansion of digital communication through social media, instant messaging, and voice-messaging apps has profoundly transformed how university students use and experience language. Research indicates that frequent engagement with these platforms encourages speech simplification, reduced vowel clarity, and increased use of casual or abbreviated phonetic patterns (Crystal, 2008; Tagliamonte & Denis, 2020). Voice notes and short video calls, while providing opportunities for oral interaction, often promote faster, less precise articulation due to their informal, rapid, and multitasking nature (Thir, 2023). These platforms create a unique linguistic environment where students naturally adapt their speech for efficiency and peer understanding, which may diverge from conventional pronunciation norms. Consequently, digital communication influences not only writing habits but also subtly reshapes spoken language, particularly in informal settings.

Pronunciation Patterns in L2 Contexts

In second-language learning, accurate pronunciation, both segmental (vowels and consonants) and suprasegmental (stress, rhythm, intonation), is essential for intelligibility and effective communication (Levis, 2018; Ladefoged & Johnson, 2014). Environmental and social factors, including peer influence and digital communication habits, can lead to shifts in these pronunciation features (Lin, Zhang, & Lin, 2022; Ojochegbe, Tersoo, & Nicodemus, 2024). For example, students frequently exposed to informal online speech may produce altered stress patterns, reduced pitch variation, and faster syllable transitions. While these adaptations may facilitate peer-to-peer comprehension within digital networks, they can hinder understanding for listeners outside the immediate social group.

Digital Communication and Pronunciation Adaptation

Recent studies suggest that digital communication represents a novel context in which L2 learners adapt their pronunciation patterns. Frequent texting, voice notes, and online calls appear to encourage abbreviated articulation and narrower pitch ranges, particularly in fast-paced, peer-oriented digital environments (Cao, Pavlik, & Bidelman, 2024; Kumari & Kumar, 2024). Research on AI-assisted pronunciation learning demonstrates that while segmental accuracy can improve with digital tools, suprasegmental features such as stress and intonation often remain underdeveloped (Senowarsito & Ardini, 2023). These findings highlight that digital communication may enhance informal peer comprehension but can reduce intelligibility for unfamiliar listeners. Understanding these dynamics is critical for educators and language practitioners seeking to balance students' informal digital habits with the need for clear, standard pronunciation, ensuring effective communication in academic and professional contexts.



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Objectives of the Study

1. How does frequent engagement in digital communication affect segmental articulation among university students?
2. What are the effects of digital communication practices on supra segmental features such as stress, rhythm, and intonation?
3. How do these pronunciation modifications influence listener intelligibility?

Research Questions

1. How does frequent engagement in digital communication affect segmental articulation among university students?
2. What are the effects of digital communication practices on supra segmental features such as stress, rhythm, and intonation?
3. How do these pronunciation modifications influence listener intelligibility?

Methodology

This study explores the effects of digital communication on university students' pronunciation patterns, examining how frequent use of texting, social media, and voice messaging influences both segmental features (vowels and consonants) and supra segmental features (stress, rhythm, and intonation). The research is structured as follows: Section 2 reviews existing literature on digital communication and its impact on spoken language; Section 3 details the methodology, including participant selection, data collection, and analysis procedures; Section 4 presents the results, highlighting changes in articulation, stress patterns, and pitch range; Section 5 discusses the findings and their implications for pronunciation and intelligibility; Section 6 explores practical applications for language teaching, speech training, and digital literacy; and Section 7 concludes with recommendations for enhancing clear and effective communication in both digital and face-to-face contexts. The study involved sixty undergraduate students (30 males and 30 females) drawn from three universities in Nigeria. Participants were aged between 18 and 25 years and were either native speakers of English or had achieved advanced English proficiency (CEFR B2–C1), ensuring a strong command of the language for reliable pronunciation analysis (Levis, 2018; Kumari & Kumar, 2024). Selection criteria required that students actively engage in digital communication for at least two hours per day, including social media interaction, instant messaging, and voice notes, to capture the influence of frequent digital language exposure. All participants reported no history of speech, hearing, or neurological impairments, which could otherwise confound pronunciation performance. Demographic and language-use questionnaires were also administered to document participants' digital habits, language background, and exposure to English in both formal and informal contexts (Ojochegebe, Tersoo, & Nicodemus, 2024).

Materials

Speech samples were elicited using three complementary tasks designed to capture both segmental and suprasegmental features:

1. Reading Tasks – Participants read lists of words and sentences carefully designed to target vowels, consonants, stress patterns, and intonation contours. These tasks provided controlled data for comparing traditional pronunciation norms with digitally influenced speech.
2. Spontaneous Speech – Participants narrated a personal experience or described a picture for two to three minutes, offering naturalistic speech that reflected everyday expressive patterns in informal contexts (Thir, 2023).



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3. Digital Voice Messages – Over a period of one week, participants submitted voice messages via WhatsApp or Telegram. This captured authentic speech influenced by digital-mediated communication, which often encourages brevity, rapid articulation, and casual prosody.

All recordings were collected using high-quality microphones and smartphones to ensure clarity and consistency. The acoustic data were subsequently analysed using Praat software for detailed phonetic examination (Boersma & Weenink, 2021).

Data Analysis

Data were analysed using a combination of acoustic, perceptual, and statistical methods:

1. Acoustic Analysis – Measurements focused on vowel formant frequencies, consonant articulation precision, fundamental frequency (F0) contours, stress placement, and syllable timing, capturing both segmental and suprasegmental features of pronunciation (Ladefoged & Johnson, 2014; Cao, Pavlik, & Bidelman, 2024).
2. Perceptual Analysis – Ten trained listeners evaluated each speech sample for intelligibility and naturalness on a 5-point Likert scale, enabling a listener-centered assessment of pronunciation clarity and comprehension (Lin, Zhang, & Lin, 2022).
3. Statistical Analysis – Mixed-effects regression models were applied to examine the relationship between participants' frequency of digital communication and pronunciation changes. Gender and age were included as covariates to control for demographic influences on speech production. This approach allowed for a robust investigation of how digital communication predicts both segmental and suprasegmental modifications in university students' speech.

Presentation of Results

Segmental and Supra segmental Features

Table 1 presents the observed differences in pronunciation patterns across three speech tasks: controlled reading, spontaneous speech, and digital voice messages. The results indicate a clear trend: frequent digital communication is associated with reduced articulatory precision and weakened prosody. Vowel space progressively narrowed from reading tasks to digital voice messages, with high and low vowels tending to centralize in informal speech. Consonant reductions, such as final /t/ and /d/ deletions, were more frequent in spontaneous and digital speech, reflecting a tendency for casual, faster articulation. Supra segmentally, stress contrasts became weaker, rhythm shifted toward syllable-timed patterns, and pitch range (F0) narrowed, particularly in shorter voice messages. Listener ratings showed that these modifications collectively diminished intelligibility, with controlled readings receiving the highest scores.

Research Questions

1. How does frequent engagement in digital communication affect segmental articulation among university students?
2. What are the effects of digital communication practices on supra segmental features such as stress, rhythm, and intonation?
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Table 1: Segmental and Supra segmental Features by Speech Task

Feature	Controlled Reading	Spontaneous Speech	Digital Messages	Voice	Observations / Notes
Vowel Space	Wide	Moderate	Narrow		Centralization of high/low vowels in informal tasks
Consonant Articulation	Precise	Slightly reduced	Reduced		/t/ and /d/ deletions are common in casual speech
Stress Contrast	Strong	Moderate	Weak		Weak stress patterns in digital voice messages
Speech Rhythm	Stress-timed	Mixed		Syllable-timed	Digital speech encourages even timing between syllables
F0 Range (Pitch)	Wide	Moderate	Narrow		Reduced pitch modulation in informal tasks
Intelligibility (Mean Score)	4.1/5	3.6/5	3.2/5		Lower intelligibility in informal speech

Statistical Correlations

To better understand how the frequency of digital communication relates to pronunciation changes and intelligibility, Pearson correlation analyses were conducted. Table 2 summarizes these relationships. The results indicate that higher digital communication frequency is significantly associated with reduced vowel clarity, weaker stress contrasts, narrower F0 ranges, and lower intelligibility scores. Stress placement and vowel precision emerged as the strongest predictors of intelligibility, reinforcing the link between segmental and supra segmental features in effective communication.

Table 2: Correlations between Digital Communication Frequency, Pronunciation Features, and Intelligibility

Variable	Vowel Clarity	Consonant Precision	Stress Contrast	F0 Range	Intelligibility
Digital Communication Frequency	-.42*	-.28*	-.50**	-.36*	-.54**
Vowel Clarity	1	.31*	.45**	.38**	.61**
Consonant Precision		1	.29*	.22	.39**
Stress Contrast			1	.40**	.68**
F0 Range				1	.42**

*p < .05, **p < .01

Summary of Findings

In essence, frequent engagement in digital communication platforms such as WhatsApp and Telegram is associated with subtle but systematic reductions in both segmental and supra segmental pronunciation features among university students. These changes, particularly vowel centralization, consonant reduction, weakened stress, and narrower pitch range, negatively affect listener intelligibility, emphasizing the importance of monitoring how informal, digital-mediated speech can influence pronunciation over time. These findings also suggest that both acoustic analysis and perceptual evaluation are critical in understanding how digital habits reshape spoken language.



Discussion of Findings

The findings of this study indicate that frequent use of digital communication platforms substantially influences university students' pronunciation, affecting both segmental and supra segmental features of speech. At the segmental level, participants showed reduced articulation precision, particularly in unstressed syllables, alongside centralized vowels and a narrowed vowel space, reflecting a tendency toward more casual and streamlined pronunciation. Consonant reductions, such as the deletion of final /t/ and /d/, were especially common in spontaneous speech and digital voice messages, highlighting how informal digital interactions encourage simplified articulation (Crystal, 2008; Tagliamonte & Denis, 2020; Hao et al., 2023). Regarding suprasegmental features, students demonstrated weaker stress contrasts and a shift toward a more syllable-timed rhythm, accompanied by reduced pitch variation, particularly in brief voice messages. This indicates that digital communication encourages prosodic patterns prioritizing speed and efficiency over careful modulation, corroborating prior research emphasizing the critical role of stress, rhythm, and intonation for intelligibility (Levis, 2018; Ojochegebe et al., 2024). Listener evaluations confirmed that stress placement and vowel clarity were the strongest predictors of intelligibility, underscoring the interplay between segmental and suprasegmental features in effective communication.

Statistical analyses revealed a negative correlation between digital communication frequency and speech intelligibility, suggesting that heavy engagement with informal, rapid digital interactions can lead to measurable declines in pronunciation accuracy. Notably, these adaptations appear systematic rather than random, reflecting habitual adjustments to digital communication constraints, such as brevity, speed, and reliance on visual text cues (Cao et al., 2024; Dossou, 2023). These results highlight the importance of targeted pronunciation instruction in university curricula, with a focus on both segmental accuracy and prosodic control. Pedagogical interventions could include structured reading exercises, prosody-focused drills, and feedback on digital speech patterns. Additionally, speech technology tools, such as automated pronunciation evaluators, should account for these digitally induced changes to better represent real-world speech. While digital platforms facilitate fast and convenient communication, they also subtly shape pronunciation habits, reinforcing the need for strategies that maintain clarity and intelligibility in both academic and professional contexts.

Implications

Language Teaching

The study highlights the crucial role of pronunciation and prosody awareness in modern language education. University educators should integrate explicit instruction on stress, rhythm, and intonation into English language and digital literacy curricula. By doing so, students can maintain intelligibility not only in informal digital exchanges but also in formal spoken communication contexts. Practical strategies might include guided reading exercises, prosody-focused drills, and voice note activities that help learners consciously monitor and adjust their speech patterns, counteracting the tendency toward casualized articulation in digital interactions (Levis, 2018; Ojochegebe, Tersoo, & Nicodemus, 2024).

Speech Technology

For developers of automatic speech recognition (ASR) and text-to-speech (TTS) systems, the findings indicate the importance of accommodating informal digital speech patterns. Speech produced over voice notes or messaging platforms often exhibits reduced articulation precision, narrower vowel



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spaces, and altered stress or intonation patterns. Training systems solely on formal speech corpora risks misrecognition or unnatural synthesis. Incorporating diverse speech samples that reflect these emerging patterns can improve system performance, making ASR and TTS more robust and inclusive across accents, age groups, and communication contexts (Dossou, 2023; de la Fuente & Jurafsky, 2024).

Professional Communication

The results also underscore the need for students and young professionals to adapt their speech according to context and audience. While rapid and casual digital communication encourages abbreviated forms and relaxed articulation, effective academic, professional, and international communication requires attention to stress placement, vowel clarity, and pitch modulation. Workshops and training that raise awareness of situational speech adaptation can help individuals strike a balance between informal digital habits and clear, intelligible oral communication, thereby enhancing overall professional efficacy (Cao, Pavlik, & Bidelman, 2024; Lin, Zhang, & Lin, 2022).

Conclusion

This study reveals that digital communication significantly shapes the pronunciation patterns of university students, influencing both segmental aspects, such as vowel quality and consonant articulation, and suprasegmental features, including stress, rhythm, and intonation. Frequent use of instant messaging, social media, and voice notes fosters faster, more casual speech, which can facilitate informal interaction but may compromise intelligibility in academic, professional, or intercultural communication settings (Levis, 2018; Lin, Zhang, & Lin, 2022). Observed changes include weaker stress contrasts, reduced vowel space, and limited pitch variation, indicating that habitual digital speech modifies natural pronunciation habits. These findings highlight the tension between the convenience of rapid, informal communication and the demands of clear, intelligible speech for audiences outside one's immediate peer group (Ojochegebe, Tersoo, & Nicodemus, 2024; Cao, Pavlik, & Bidelman, 2024). Overall, the study underscores the need for balanced strategies that support both adaptive digital communication and preservation of oral clarity.

Recommendations

Based on these insights, several practical recommendations are proposed:

1. **Language Teaching:** Educators should integrate pronunciation and prosody training into English and digital literacy curricula. Activities could include reading exercises, guided oral presentations, and voice note tasks to help students retain clarity while adapting to informal digital speech (Ojochegebe, Tersoo, & Nicodemus, 2024).
2. **Speech Technology:** Developers of automatic speech recognition (ASR) and text-to-speech (TTS) systems should incorporate informal digital speech patterns into training datasets. This approach can enhance system accuracy and naturalness across diverse accents and communication styles (Dossou, 2023; de la Fuente & Jurafsky, 2024).
3. **Professional Communication:** Students and young professionals should be trained to modulate their speech depending on the audience and context, balancing casual digital habits with standard pronunciation norms. This ensures intelligibility in formal, academic, or international settings and supports effective cross-context communication (Cao, Pavlik, & Bidelman, 2024).

In conclusion, a strategic combination of educational, technological, and professional interventions can help mitigate the unintended effects of digital communication on pronunciation, enabling university students to remain clear, intelligible, and adaptable communicators across a variety of contexts.



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Assessment of Major Factors of ... Lawal, M. & Umar, M. A. (2025)

Assessment of Major Factors of Climate Change within the Period 1990-2024 in North-Western Region of Nigeria

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Abstract

This study examines the escalating environmental degradation in three states of North-West Nigeria (Katsina, Kebbi, and Zamfara), focusing on desertification and drought as critical manifestations of climate change. The region, characterized by low and erratic rainfall (500-800mm annually) and rising temperatures, is experiencing significant land degradation, including soil erosion, vegetation loss, and declining soil fertility. Drought events are becoming more frequent and severe, jeopardizing agriculture and food security for the largely rain-fed farming population. Using climate data from 1990 to 2024 and survey data from 1050 randomly selected respondents across the three states, the research analyzes temperature and precipitation trends, spatial patterns of desertification, the role of human activities, and identifies vulnerability hotspots. Key findings include a regional temperature increase of 1.8°C, a 10.2% decline in annual precipitation, and a 64.7% rise in areas with moderate to severe desertification across the three states. Katsina exhibits the highest vulnerability with 28.5% of its area under severe desertification. The study highlights the impact of human activities, such as fuelwood collection and overgrazing, on desertification and identifies key vulnerability hotspots in the northern parts of these states and around urban centers. It recommends integrated interventions, including landscape restoration, sustainable land management, and policy reforms, to combat desertification and enhance resilience, aiming to foster sustainable development in the region.

Keywords: Climate Change, Environmental Degradation, Vulnerability Assessment, Sustainable Land Management

Introduction

Katsina, Kebbi, and Zamfara states, situated in North-West Nigeria, have experienced intensifying environmental degradation over recent decades, with desertification and drought emerging as predominant manifestations of climate change in the region. Located in the Sudan-Sahel ecological zone, these states form a critical agricultural belt in Nigeria yet face growing threats from advancing desert frontiers and increasingly erratic rainfall patterns (Olagunju, 2015). The semi-arid nature of these states, characterized by annual rainfall averages ranging from 500mm to 800mm, renders them particularly susceptible to desertification processes and drought events, which have been exacerbated by climate change (Oladipo, 2018). Desertification in these states manifests as the progressive degradation of productive lands through soil erosion, vegetation loss, and declining soil fertility, ultimately reducing the land's capacity to support agriculture and pastoral livelihoods. Concurrently, drought events have become more frequent and severe, disrupting traditional agricultural calendars and threatening food security for millions of residents who depend primarily on rain-fed agriculture (Abdulkadir et al., 2017). The intersection of these twin phenomena—



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desertification and drought—represents a complex challenge that demands robust scientific investigation and targeted policy interventions. The significance of desertification and drought in Katsina, Kebbi, and Zamfara extends beyond environmental concerns to encompass critical socioeconomic dimensions. Approximately 75% of the population in these three states relies directly on agriculture for their livelihoods, making them highly vulnerable to climate-induced land degradation (Nkechi et al., 2016). Furthermore, the region's population growth rate of approximately 3.6% annually intensifies pressure on already fragile land resources, creating a cycle wherein human activities accelerate desertification, which in turn compromises productive capacity (Abdullahi et al., 2020).

Desertification represents a complex land degradation process occurring in arid, semi-arid, and dry sub-humid areas, resulting from various factors including climatic variations and human activities (UNCCD, 2017). The conceptualization of desertification has evolved significantly since the United Nations Conference on Desertification in 1977, moving from simplistic notions of "desert advancement" toward more nuanced understandings that recognize multiple interacting biophysical and socioeconomic drivers (Reynolds et al., 2007). In the specific context of Katsina, Kebbi, and Zamfara states, scholars have proposed several frameworks for understanding desertification. Olagunju (2015) characterizes desertification in the region as a progressive decline in ecosystem services, manifesting through reduced vegetation cover, compromised soil structure, and diminished water retention capacity. Abdulkadir et al. (2017) expand this conceptualization by emphasizing the role of land use intensification, particularly overgrazing and deforestation, in accelerating natural aridity processes. Additionally, Nkechi et al. (2016) highlights the importance of understanding desertification as a socio-ecological phenomenon driven by the interaction between environmental conditions and human adaptation strategies. The Dryland Development Paradigm (DDP) proposed by Reynolds et al. (2007) offers a particularly relevant theoretical framework for analyzing desertification in these three states. This paradigm emphasizes five key principles: (1) the coupled nature of socio-ecological systems; (2) the critical importance of slowly changing variables; (3) the existence of thresholds in system dynamics; (4) the hierarchical structure of cross-scale interactions; and (5) the hybrid knowledge needed to understand these complex systems. This framework helps conceptualize desertification not merely as environmental degradation but as a system-level transformation resulting from multiple interacting processes across temporal and spatial scales.

Drought represents a recurring feature of climate variability characterized by a deficiency of precipitation over an extended period, resulting in water shortage for some activity, group, or environmental sector (Wilhite and Glantz, 1985). The literature distinguishes four primary categories of drought: meteorological drought (precipitation deficits), agricultural drought (soil moisture deficits), hydrological drought (reduced streamflow and reservoir levels), and socioeconomic drought (demand exceeding supply of economic goods) (Mishra and Singh, 2010). Various indices have been developed to quantify drought severity and extent, each capturing different aspects of the phenomenon. The Standardized Precipitation Index (SPI), developed by McKee et al. (1993), has gained widespread adoption for its flexibility across timescales and its statistical robustness. For Katsina, Kebbi, and Zamfara states, several studies have applied the SPI to characterize historical drought patterns. Oladipo (2018) analyzed SPI values across 30-year periods, finding increasing frequency of moderate to severe drought events since the 1970s. Similarly, Mohammed et al. (2018) utilized the Palmer Drought Severity Index (PDSI) to document a statistically significant trend toward more intense drought conditions in Katsina and Zamfara states. More recently, composite indices



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that incorporate multiple variables have gained traction in drought assessment. The Standardized Precipitation Evapotranspiration Index (SPEI), which accounts for both precipitation and potential evapotranspiration, has proven particularly valuable for regions experiencing warming trends alongside precipitation changes (Vicente-Serrano et al., 2010). Ismail et al. (2019) applied SPEI to Katsina, Kebbi, and Zamfara states, demonstrating that temperature-driven increases in evaporative demand have exacerbated drought conditions even in years with near-normal rainfall. The drivers of desertification and drought in semi-arid regions like Katsina, Kebbi, and Zamfara can be broadly categorized into climatic factors and anthropogenic activities, with complex interactions between these categories. From a climatic perspective, research has identified several key drivers relevant to the region:

Climatic Factors; Global climate change has altered temperature and precipitation patterns in ways that intensify desertification processes. Odjugo (2010) documented a steady increase in mean annual temperature across northern Nigeria, with an average rise of 1.1°C over the past century and an accelerated warming trend of 0.04°C per year since 1971. Concurrently, Nicholson et al. (2018) observed a southward shift in isohyets (lines of equal rainfall) by approximately 200km since the 1960s, indicating a progressive drying of the region. Additionally, rainfall variability has increased significantly, with more frequent extreme events interspersed with prolonged dry spells (Abiodun et al., 2018).

Anthropogenic Factors: Human activities significantly influence desertification processes in the three states. Usman and Nichol (2018) identified agricultural expansion and intensification as primary drivers, with cultivated land area in Katsina state increasing by 36% between 1995 and 2013, largely at the expense of natural vegetation. Similarly, unsustainable livestock management practices, particularly overgrazing in communal rangelands, have contributed to vegetation degradation and soil compaction (Abdullahi et al., 2020). Deforestation represents another critical anthropogenic driver, with fuelwood collection and charcoal production reducing forest cover by approximately 3.5% annually in parts of Kebbi state (Momodu et al., 2011). The interaction between climatic and anthropogenic factors often creates feedback loops that accelerate desertification. For instance, vegetation removal reduces evapotranspiration and increases surface reflectivity (albedo), potentially reducing local rainfall and reinforcing aridity (Charney, 1975). These bio-geophysical feedbacks, coupled with socioeconomic pressures from population growth and changing livelihood strategies, create what Mortimore and Adams (2001) term "poverty-environment traps" wherein resource degradation and economic vulnerability mutually reinforce each other.

This article aims to analyze the extent, patterns, and driving factors of desertification and drought in Katsina, Kebbi, and Zamfara states, utilizing climate data spanning from 1990 to 2024 and survey data from 1050 randomly selected respondents across the three states. Specifically, the study seeks to: (1) quantify changes in temperature and precipitation patterns across the three states; (2) examine the spatial progression of desert encroachment in the region; (3) evaluate the relationship between human activities and desertification processes; and (4) identify vulnerability hotspots requiring prioritized intervention. Through rigorous analysis of climate trends, land degradation patterns, and survey responses, this article will provide an empirical foundation for targeted adaptation and mitigation strategies.

Statement of the Problem



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The states of Katsina, Kebbi, and Zamfara are facing serious climate issues like desertification, unpredictable rainfall, and extreme heat. These problems pose a significant threat to people's livelihoods and food security. However, there is a clear lack of focused research that identifies and ranks the main causes of these changes in this tri-state area. Although human activities like deforestation, unsustainable farming, and biomass burning are recognized, their specific impacts and local factors have not been measured. This gap in knowledge makes it hard to create effective, evidence-based policies. As a result, general and often ineffective strategies are used to address these issues. Environmental damage continues to worsen, increasing vulnerability in one of Nigeria's most climate-sensitive regions.

Objectives of the study

The aim of this study was to investigate the major drivers of climate change in north west Nigeria states of Katsina, Kebbi and Zamfara states respectively. The specific objectives were to:

1. Assess and quantify changes in temperature and precipitation patterns across the affected states in the study.
2. Examine the spatial progression of desert encroachment in the affected state in the region.
3. Evaluate the relationship between human activities and desertification processes.
4. Identify vulnerability hotspots requiring special intervention.

Research Questions

The following research questions were raised to guide the study:

1. What is the magnitude, direction, and statistical significance of trends in annual mean temperature, seasonal rainfall totals, and rainfall variability in the study area?
2. What is the extent and patterns of special average annual rate of desertification in the region?
3. What is the nature and strength of the correlation between proxies for human activity and observed indices of land degradation?
4. Which specific Areas(state) exhibit the highest level of vulnerability and exposure to climatic changes.

Hypothesis

The following Hypotheses were raised to guide the study:

- H₁: There has been a statistically significant increase in mean annual temperature and a significant decrease in total annual rainfall across the three states.
- H₂: There has been significant increase in desertification in the affected states due to their geographical positioning and land use profile
- H₃: Strong positive correlation exists between high-density human activity zones and severe land degradation,
- H₄: Highly vulnerable and critical hotspots exist in the affected states

Methodology

Data Sources

This study employs multiple data sources to comprehensively analyse desertification and drought patterns in Katsina, Kebbi, and Zamfara states:

Climate Data: Historical temperature and precipitation records from 1990 to 2024 were obtained from the Nigerian Meteorological Agency (NiMet) for 6 weather stations distributed across the three states (2 stations per state). These station-based observations were supplemented with gridded climate data from the Climate Research Unit Time Series (CRU TS) dataset version 4.06, which provides monthly climate variables at 0.5° × 0.5° spatial resolution (Harris et al., 2020). Additionally, future climate projections (2023-2025) were derived from the ensemble mean of five Global Climate



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Models (GCMs) under the SSP2-4.5 emissions scenario, downscaled to a resolution appropriate for regional analysis.

Remote Sensing Data: To assess land cover changes and desertification patterns, we utilized multi-temporal satellite imagery from multiple platforms: (i) Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM+), and Landsat 8 Operational Land Imager (OLI) images at 30m spatial resolution for the years 1990, 2000, 2010, and 2020 (ii) Moderate Resolution Imaging Spectroradiometer (MODIS) vegetation indices (NDVI and EVI) at 250m resolution for the period 2000-2024 (iii) Advanced Very High-Resolution Radiometer (AVHRR) data for the period 1990-1999

Field Survey and Socioeconomic Data: Primary data were collected through a comprehensive field survey involving 1050 respondents randomly distributed across the three states (350 respondents per state). The survey was conducted among the three states capturing information on observed environmental changes, agricultural practices, water availability, energy sources, and adaptation strategies. Additionally, at 18 sampling sites (6 per state) representing different ecological zones, measurements included ground-based vegetation assessment using the line-intercept method, soil sampling for texture and organic matter analysis, and documentation of land use practices. To assess human factors in desertification processes, we incorporated demographic and agricultural statistics from the National Bureau of Statistics (Nigeria), state-level agricultural departments, and the Food and Agriculture Organization (FAO). These included population density maps, livestock numbers, agricultural land use, and fuelwood consumption statistics.

Analytical Approach for Trend Assessment

The analytical framework employed multiple statistical and geospatial techniques to examine desertification and drought trends:

Climate Trend Analysis: Long-term trends in temperature and precipitation were analyzed using the Mann-Kendall non-parametric test to detect monotonic trends while accounting for seasonal effects. The magnitude of trends was estimated using Sen's slope estimator, which is less sensitive to outliers than linear regression. For drought assessment, we calculated the Standardized Precipitation Evapotranspiration Index (SPEI) at 3-, 6-, and 12-month timescales following the methodology of Vicente-Serrano et al. (2010). Drought events were classified as moderate (SPEI < -1.0), severe (SPEI < -1.5), or extreme (SPEI < -2.0).

Desertification Assessment: Land degradation was quantified using the following approaches: (i) Normalized Difference Vegetation Index (NDVI) trend analysis using seasonal trend decomposition to separate long-term trends from seasonal variations (ii) Land cover classification and change detection using supervised classification with Random Forest algorithm, validated through ground reference data (iii) Calculation of the Land Degradation Neutrality (LDN) indicator following UNCCD methodology, based on changes in land productivity, land cover, and soil organic carbon

Statistical Modeling: To examine relationships between environmental variables and socioeconomic factors, we employed multiple statistical techniques: (i) Principal Component Analysis (PCA) to identify dominant patterns of variability in the climate and land degradation data (ii) Multiple regression analysis to quantify relationships between desertification indicators and potential driving factors (iii) Spatial autocorrelation analysis using Moran's I statistics to identify clustering patterns in desertification processes (iv) Analysis of survey responses from 1050 respondents to assess perceived environmental changes, adaptation strategies, and socioeconomic impacts

All statistical analyses were performed using Stata 17 software, with spatial analyses conducted in ArcGIS Pro 3.0 and QGIS 3.28. The significance level was set at $\alpha = 0.05$ for all statistical tests.



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Spatial and Temporal Framework of the Analysis

The study encompasses Katsina, Kebbi, and Zamfara states of Nigeria, covering approximately 100,754 km² (Katsina: 24,192 km², Kebbi: 36,800 km², Zamfara: 39,762 km²). For analytical purposes, the region was divided into 0.5° × 0.5° grid cells aligned with the climate data resolution, resulting in 40 analysis units across the three states. These units were further stratified based on agroecological zones, distinguishing between the Sudan Savannah and the Northern Guinea Savannah subregions. Temporally, the analysis spans from 1990 to 2024, divided into seven 5-year periods (1990-1994, 1995-1999, 2000-2004, 2005-2009, 2010-2014, 2015-2019, 2020-2024) to facilitate the detection of medium-term trends while smoothing interannual variability. This temporal framework allows for the assessment of: (i) Historical trends in climate variables and land degradation indicators (1990-2024) (ii) Changes in human perceptions and adaptation strategies over time based on survey data (iii) Identification of potential acceleration or deceleration in desertification processes over time.

To ensure robust change detection, baseline conditions were established using the 1990-1994 period, with subsequent periods analyzed relative to this baseline. For the identification of vulnerability hotspots, a multi-criteria evaluation framework was developed that integrates biophysical indicators (aridity index, NDVI trends, soil characteristics) with socioeconomic factors (population density, poverty rates, livelihood diversification) to produce a composite vulnerability index.

Analysis and Results Interpretation

Research Question 1: What is the magnitude, direction, and statistical significance of trends in annual mean temperature, seasonal rainfall totals, and rainfall variability in the study area?

Trends in Temperature and Precipitation (1990-2024)

The analysis of climatological data across Katsina, Kebbi, and Zamfara states revealed significant changes in both temperature and precipitation patterns over the study period. Table 1 presents the results of temperature trend analysis by state, indicating a consistent warming trend across the entire region, though with spatial variations in the magnitude of change.

Table 1: Temperature Trends in Katsina, Kebbi, and Zamfara States (1990-2024)

State	Mean Annual Temp. 1990-1994 (°C)	Mean Annual Temp. 2019-2024 (°C)	Mean Change (°C)	Sen's Slope (°C/year)	p-value	Significance
Katsina	27.1	29.1	+2.0	0.061	<0.001	***
Kebbi	27.8	29.5	+1.7	0.052	0.002	**
Zamfara	26.9	28.7	+1.8	0.055	0.001	***
Regional Average	27.3	29.1	+1.8	0.056	<0.001	***

Note: ** significant at $p < 0.01$; *** significant at $p < 0.001$

As evident from Table 1, all three states experienced statistically significant warming over the 34-year period (1990-2024). The most pronounced warming occurred in Katsina state, with a mean annual temperature increase of 2.0°C and a trend of 0.061°C per year. Zamfara and Kebbi followed with increases of 1.8°C and 1.7°C, respectively. The regional average warming of 1.8°C (0.056°C/year) substantially exceeds the global average warming of approximately 0.18°C per decade reported by the IPCC for the same period (IPCC, 2021), highlighting the enhanced vulnerability of this semi-arid region to climate change. Survey responses from the 1050 respondents across the



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three states corroborated these instrumental records. When asked about perceived temperature changes over the past 20-30 years, 88.7% of respondents reported that temperatures had increased, with 67.3% characterizing the increase as "substantial." This perception was most pronounced among respondents in Katsina state, where 93.2% reported increased temperatures.

Seasonal analysis revealed that warming trends were not uniform throughout the year. The largest temperature increases occurred during the dry season months (October-April), with February and March showing the highest rates of warming (0.075°C/year on average). This amplified dry season warming potentially extends the period of high evapotranspiration and water stress, exacerbating drought conditions even without changes in precipitation. Precipitation trends across the three states show a more complex pattern than temperature, with substantial spatial and temporal variability. Table 2 presents the precipitation trend analysis by state, revealing divergent patterns across the region.

Table 2: Precipitation Trends in Katsina, Kebbi, and Zamfara States (1990-2024)

State	Mean Annual Precip. 1990-1994 (mm)	Mean Annual Precip. 2019-2024 (mm)	Mean Change (mm)	Sen's Slope (mm/year)	p-value	Significance
Katsina	684	591	-93	-2.82	0.021	*
Kebbi	768	721	-47	-1.43	0.132	ns
Zamfara	726	653	-73	-2.21	0.038	*
Regional Average	726	655	-71	-2.15	0.029	*

Note: ns = not significant; * significant at $p < 0.05$

While all three states showed declining precipitation trends, the magnitude and statistical significance varied considerably. Katsina and Zamfara states exhibited statistically significant decreases in annual precipitation, with Katsina showing the most substantial decline of 93mm over the study period (2.82mm/year). Although Kebbi showed a negative trend, it was not statistically significant at the $\alpha = 0.05$ level. The regional average indicates a significant decline of 71mm in annual precipitation (2.15mm/year), representing approximately a 9.8% reduction in rainfall since 1990. Survey data strongly aligned with these instrumental observations. Among the 1050 respondents, 82.3% reported perceived decreases in rainfall amounts, with 79.1% noting changes in rainfall timing or distribution. The highest percentage of respondents reporting rainfall decreases was in Katsina (89.7%), followed by Zamfara (84.1%) and Kebbi (73.2%).

Beyond these annual averages, important changes were observed in precipitation characteristics:

- i. **Rainfall Onset and Cessation:** Analysis of pentad (5-day) rainfall accumulation revealed a statistically significant delay in the onset of the rainy season by approximately 9-13 days ($p < 0.05$) across the three states since 1990, with the most pronounced delays in northern Katsina. Concurrently, an earlier cessation of rains by 5-8 days was observed, effectively shortening the growing season by approximately two weeks.



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- ii. **Rainfall Intensity and Distribution:** Despite the overall decline in annual precipitation, the number of heavy rainfall events (>30mm/day) increased by 19% across the three states, while the number of rain days decreased by 16%. This indicates a shift toward more intense but less frequent rainfall events, with longer dry spells between rains—a pattern particularly problematic for rain-fed agriculture.
- iii. **Spatial Regression of Isohyets:** Spatial analysis of 30-year average rainfall isohyets showed a southward shift of approximately 35-45km for the critical 600mm isohyet that roughly marks the limit of reliable rain-fed agriculture. This shift has effectively expanded the zone of high agricultural vulnerability. The findings agrees with Hypothesis 1

Research Question 2: what is the extent and patterns of average annual rate of desertification in the region?

Desert Encroachment Patterns across the Three States

The analysis of satellite imagery and derived vegetation indices revealed significant land degradation across Katsina, Kebbi, and Zamfara states, though with considerable spatial heterogeneity in the patterns and rates of desertification. Table 3 quantifies the extent of different desertification categories by state.

Table 3: Extent of Desertification Categories by State (1990-2024)

State	Total Area (km ²)	Severe Desertification (%)	Moderate Desertification (%)	Stable/Slight Degradation (%)	Improvement (%)
Katsina	24,192	28.5	45.2	22.8	3.5
Kebbi	36,800	15.8	37.9	39.7	6.6
Zamfara	39,762	19.3	41.2	34.5	5.0
Regional Total	100,754	20.5	41.2	33.0	5.3

Note: Classification based on combined assessment of NDVI trends, land cover changes, and field verification. Severe desertification indicates >40% reduction in vegetation productivity; moderate desertification indicates 15-40% reduction; stable/slight degradation indicates 0-15% reduction; improvement indicates increase in vegetation productivity.

These results reveal that approximately 61.7% of the three states' land area has experienced moderate to severe desertification over the 34-year study period, with only 5.3% showing signs of improvement. The spatial pattern of desertification follows a general north-south gradient, with the northern parts of Katsina experiencing the most severe degradation. However, this gradient is modified by local factors, creating a more complex mosaic of degradation patterns. Survey responses from the 1050 randomly selected participants provide valuable insights into public perceptions of land degradation. When asked about observed changes in vegetation cover over their lifetime, 86.5% of respondents reported decreases, with 59.7% characterizing these decreases as "severe." The highest perception of vegetation loss was reported in Katsina (92.1% of respondents), followed by Zamfara (87.4%) and Kebbi (80.0%).

Land cover change analysis provides additional insight into the desertification process. Between 1990 and 2024, the three states experienced a net loss of 34.2% of natural vegetation cover (including woodlands, shrublands, and perennial grasslands). Conversely, bare ground and sparsely vegetated areas increased by 31.3%, while cultivated land initially expanded by 17.5% between 1990 and 2005 but subsequently contracted by 5.3% between 2005 and 2024 as land degradation rendered some



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areas unsuitable for cultivation. The most rapid rates of desertification were observed in the 2000-2010 decade, coinciding with a period of accelerated population growth, expanded agricultural activities, and increased rainfall variability. The rate of desertification has moderated slightly since 2010, potentially reflecting increased awareness and implementation of soil and water conservation measures in some areas, although the overall trend remains negative.

- iv. Analysis of the fractional vegetation cover (FVC) derived from high-resolution satellite imagery provides further evidence of the desertification process. The average FVC across the three states decreased from 41.2% in 1990 to 27.8% in 2024, representing a 32.5% reduction in vegetation density. This trend was most pronounced in Katsina state, where average FVC declined by 36.9%, followed by Zamfara (32.7%) and Kebbi (28.4%). The findings equally agrees with Hypothesis 2 There has been significant increase in desertification in the affected states.

Research Question 3: What is the nature and strength of the correlation between proxies for human activity and observed indices of land degradation.

Relationship between Human Activities and Desertification

Statistical analysis of the relationship between human activities and desertification indicators revealed significant associations, as summarized in Table 4.

Table 4: Multiple Regression Analysis of Desertification Drivers in the Three States

Independent Variable	Coefficient	Std. Error	t-value	p-value	Significance
Population Density (people/km ²)	-0.0172	0.0033	-5.21	<0.001	***
Cropland Expansion (% change)	-0.0226	0.0051	-4.43	<0.001	***
Livestock Density (TLU/km ²)	-0.0207	0.0039	-5.31	<0.001	***
Fuelwood Collection (tons/km ²)	-0.0365	0.0065	-5.62	<0.001	***
Distance to Water Sources (km)	-0.0293	0.0058	-5.05	<0.001	***
SPI (12-month average)	0.0412	0.0084	4.90	<0.001	***
Temperature Anomaly (°C)	-0.0332	0.0073	-4.55	<0.001	***
Slope Gradient (%)	-0.0171	0.0055	-3.11	0.002	**
Soil Organic Matter (%)	0.0503	0.0094	5.35	<0.001	***
Protected Area Status (dummy)	0.0245	0.0069	3.55	<0.001	***

Note: Dependent variable is annual NDVI change (continuous variable ranging from negative to positive values, with negative values indicating degradation); $R^2 = 0.69$; Adjusted $R^2 = 0.66$; $n = 40$ grid cells; TLU = Tropical Livestock Unit; SPI = Standardized Precipitation Index; ** significant at $p < 0.01$; *** significant at $p < 0.001$

The regression model explained approximately 69% of the spatial variation in vegetation degradation (as measured by NDVI change), indicating that the combination of anthropogenic and climatic factors accounts for most of the observed desertification patterns. All variables included in the model showed statistically significant relationships with land degradation, with fuelwood collection exhibiting the strongest negative association among human factors. This finding aligns with field observations and



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survey responses indicating that wood harvesting for fuel and commercial charcoal production has resulted in widespread deforestation, particularly around urban centers and along major transportation corridors. Survey data from the 1050 respondents reinforced these statistical findings. When asked about primary energy sources, 78.2% of respondents reported relying on fuelwood as their main cooking energy source, with particularly high dependence in rural areas of all three states. Furthermore, 63.7% of respondents reported increasing difficulty in accessing fuelwood over the past decade, necessitating longer collection times or greater expenditure for purchased wood.

Population density showed a significant negative relationship with vegetation conditions, supporting the hypothesis that demographic pressure contributes to land degradation through increased resource demands. However, the relationship is not strictly linear, as evidenced by spatial analysis showing that some areas with moderate population density but poor land management practices experienced more severe degradation than certain high-density areas where sustainable practices have been adopted. The significant negative relationship between livestock density and vegetation conditions highlights the impact of grazing pressure on land resources. Field surveys revealed that areas with high livestock concentrations, particularly in northern Katsina state, exhibited soil compaction, reduced plant diversity, and diminished vegetation cover. Transhumance routes, traditionally used by pastoralists moving seasonally between ecological zones, showed particularly severe degradation, reflecting both intensive use and the breakdown of traditional management systems. Among the survey respondents involved in livestock keeping (64.3% of the total sample), 71.8% reported increasing difficulties in finding adequate grazing land over the past decade. This perception was most pronounced in Katsina (82.3%) and Zamfara (76.5%), and somewhat lower in Kebbi (57.4%). Among climatic factors, both precipitation (measured by SPI) and temperature anomalies significantly influenced vegetation condition, with drought periods strongly associated with accelerated land degradation. Importantly, the interaction between climatic and anthropogenic factors appears to create synergistic effects that amplify degradation beyond what either factor would produce individually.

Principal Component Analysis (PCA) identified three primary components explaining 74% of the variance in desertification patterns across the three states: (i) A "climate-driven degradation" component (32.6% of variance), strongly associated with drought indices and temperature anomalies (ii) A "resource extraction" component (25.9% of variance), associated with fuelwood collection, cultivation intensity, and distance to settlements (iii) A "grazing pressure" component (15.5% of variance), associated with livestock density and mobility patterns

This multifactorial nature of desertification underscores the need for integrated approaches to address both the climatic and anthropogenic dimensions of the problem. The findings is in agreement with Hypothesis (H₃): Strong positive correlation exists between high-density human activity zones and severe land degradation.

Research Question 4: Which specific Areas(state)exhibit the highest level of vulnerability and exposure to climatic changes

Identification of Critical Zones and Vulnerability Hotspots

The integration of desertification indicators, climate vulnerability metrics, and socioeconomic data allowed for the identification of critical zones and vulnerability hotspots across Katsina, Kebbi, and Zamfara states. Table 5 presents the vulnerability classification of areas within each state.



Table 5: Vulnerability Classification of Areas in the Three States

State	Extreme Vulnerability (% of area)	High Vulnerability (% of area)	Moderate Vulnerability (% of area)	Low Vulnerability (% of area)
Katsina	32.6	42.8	18.7	5.9
Kebbi	18.5	39.2	32.1	10.2
Zamfara	23.8	39.7	29.4	7.1
Regional Average	24.5	40.4	27.2	7.9

Note: Vulnerability classification based on composite index incorporating biophysical indicators (NDVI trends, aridity index, soil degradation) and socioeconomic factors (population density, poverty rates, infrastructure access)

The analysis identified 24.5% of the three states' area as facing extreme vulnerability to desertification and drought, with an additional 40.4% classified as highly vulnerable. Spatially, these vulnerability hotspots are concentrated in: (i) The northern portions of Katsina and parts of northern Zamfara, where advancing desert conditions, high aridity indices, and limited alternative livelihoods create severe challenges (ii) Areas surrounding major urban centers, including the peripheries of Katsina, Gusau (Zamfara), and Birnin Kebbi cities, where high population pressure and intensive resource extraction have led to circular patterns of degradation (iii) Transboundary zones along the Nigeria-Niger border in Katsina state, characterized by high mobility of people and livestock, contested resource access, and limited governance capacity.

Survey responses provided insights into community perceptions of vulnerability. When asked to rate the severity of environmental changes in their localities, respondents in northern Katsina reported the highest perceived impact (average severity rating of 4.6 on a 5-point scale), followed by northern Zamfara (4.3) and northern Kebbi (3.9). Temporal analysis indicates that both the extent and intensity of vulnerability have increased over the study period, with areas classified as highly or extremely vulnerable expanding from 48.2% of the region in 1990 to 64.9% in 2024. This expansion has predominantly occurred through the conversion of moderately vulnerable areas to highly vulnerable status, reflecting the progressive nature of desertification processes. Socioeconomic vulnerability amplifies the impact of biophysical degradation. Areas with limited livelihood diversification, poor market access, and inadequate infrastructure demonstrated reduced adaptive capacity to climate stressors. Notably, communities with high dependence on natural resource-based livelihoods (exceeding 75% of household income) exhibited the greatest susceptibility to desertification impacts, with livelihood diversification serving as a key resilience factor. The survey revealed that adaptation strategies varied by vulnerability level. In areas of extreme vulnerability, migration (seasonal or permanent) was reported by 42.3% of respondents as a key coping strategy. In contrast, areas of moderate vulnerability showed higher rates of agricultural adaptation through changed planting dates (68.7%) and crop diversification (57.4%).



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Geospatial analysis of vulnerability trends revealed directional patterns of desertification, with a general southward progression of high-vulnerability zones at an average rate of 0.7-1.3 km per year. However, this progression is not uniform, with "leapfrog" patterns emerging where isolated degradation hotspots develop ahead of the main degradation front, often associated with localized resource extraction or land use intensification. These spatial dynamics present challenges for containment strategies and highlight the need for anticipatory rather than reactive interventions. The findings equally support Hypothesis 4 (H₄): Highly vulnerable and critical hotspots exist in the areas affected by desertification.

Key Findings on Desertification and Drought Trends

The major findings can be summarized as follows:

- i. Temperature across the three states has increased by an average of 1.8°C between 1990 and 2024, with warming most pronounced during the dry season. This rate of warming (0.056°C/year) substantially exceeds global averages for the same period. Annual precipitation has declined by an average of 9.8% across the three states, with statistically significant decreases in Katsina and Zamfara states. More importantly, rainfall patterns have become increasingly erratic, with delayed onset, earlier cessation, fewer rainy days, and more intense rainfall events.
- ii. Approximately 61.7% of the three states' land area has experienced moderate to severe desertification over the 34-year study period, with natural vegetation cover declining by 34.2% and bare ground increasing by 31.3%.
- iii. Human activities—particularly fuelwood collection, livestock grazing, and agricultural expansion—have significantly contributed to desertification processes, with statistical models indicating that anthropogenic factors explain a substantial portion of observed land degradation patterns.
- iv. Climate and human factors interact synergistically, creating amplifying feedback that accelerates desertification beyond what either factor would produce individually.
- v. Vulnerability to desertification and drought is unevenly distributed, with 64.9% of the region classified as highly or extremely vulnerable, concentrated in northern Katsina, northern Zamfara, and areas surrounding major urban centers.
- vi. Survey data from 1020 respondents across the three states confirmed widespread public perception of environmental change, with 88.7% reporting increased temperatures, 82.3% perceiving decreased rainfall, and 86.5% noting vegetation loss.

These findings confirm that desertification and drought represent major manifestations of climate change in Katsina, Kebbi, and Zamfara states, with significant implications for ecosystem sustainability, agricultural productivity, and human welfare. The observed trends suggest that without substantial intervention, the region faces increasing environmental degradation and livelihood challenges in the coming decades.

Implications for Ecosystem Sustainability

The documented patterns of desertification and drought carry profound implications for ecosystem sustainability across the three states. The progressive degradation of vegetation cover compromises critical ecosystem services, including:

- i. **Biodiversity Support:** Natural vegetation communities have experienced fragmentation and compositional shifts, with drought-tolerant and grazing-resistant species becoming increasingly dominant. Field surveys documented an average 40% reduction in plant species richness in severely degraded areas compared to reference sites, with native perennial grasses particularly affected.



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- ii. **Hydrological Regulation:** Reduced vegetation cover and soil degradation have altered hydrological processes, increasing surface runoff and decreasing infiltration. This hydrological disruption manifests in more erosive flood events during intense rains and reduced moisture availability during dry periods, effectively amplifying both flood and drought impacts.
- iii. **Carbon Storage:** Soil organic carbon has declined by an estimated 45% in severely degraded areas, representing both a loss of soil fertility and a contribution to atmospheric carbon dioxide levels. This carbon loss creates positive feedback to climate change while reducing the productive capacity of the land.
- iv. **Microclimate Regulation:** Vegetation loss alters surface energy balances, potentially reinforcing aridity through reduced evapotranspiration and increased surface albedo. Local temperature measures showed that severely degraded areas exhibited daytime surface temperatures 3-7°C higher than adjacent vegetated areas.

These ecosystem impacts are not merely environmental concerns but directly affect human welfare through compromised agricultural productivity and increased vulnerability to climate extremes. The degradation trajectory observed in some areas suggests the potential for threshold-crossing events, where degradation becomes effectively irreversible under current climatic conditions, highlighting the urgency of intervention. Survey responses indicated growing awareness of these ecological connections. Among the 1020 respondents, 73.8% identified direct links between vegetation loss and other environmental changes such as reduced water availability (mentioned by 68.5%), increased erosion (62.9%), and greater temperature extremes (57.2%).

Conclusion

This study has documented significant climate change impacts across Katsina, Kebbi, and Zamfara states, characterized by increasing temperatures, declining and increasingly erratic precipitation, and widespread land degradation.

Recommendations

Practical Interventions for Combating Desertification

Based on the findings of this study, several practical interventions can be recommended to combat desertification and mitigate drought impacts in Katsina, Kebbi, and Zamfara states:

Landscape Restoration Approaches:

 Implementing integrated landscape management through:

- i. Assisted natural regeneration (ANR) of degraded woodlands, particularly focusing on native Acacia species and other drought-tolerant natives
- ii. Establishment of greenbelts and shelter belts in strategic locations to reduce wind erosion and create microclimate benefits
- iii. Implementation of soil and water conservation structures (half-moons, stone bunds, etc.) to maximize water infiltration and reduce erosion

Sustainable Land Management Practices:

Promoting agricultural techniques that enhance resilience:

- i. Farmer-managed natural regeneration (FMNR) to integrate trees into farming systems
- ii. Conservation agriculture practices (minimum tillage, cover cropping, crop rotation) to improve soil health Agroforestry systems that combine production with environmental benefits
- iii. Improved rangeland management through rotational grazing and strategic placement of water points

Alternative Energy Solutions: Addressing fuelwood demand through:



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- i. Promotion of improved cookstoves that reduce firewood consumption by 40-60%
- ii. Development of community woodlots for sustainable fuelwood production
- iii. Exploration of alternative energy sources, including solar cookers and biogas systems

Water Management Innovations: Enhancing water security through:

- i. Small-scale irrigation technologies such as California drip systems and treadle pumps
- ii. Rainwater harvesting techniques at household and community scales
- iii. Floodwater harvesting systems to capture and utilize seasonal flows
- iv. Rehabilitation of traditional water harvesting structures

Livelihood Diversification: Reducing pressure on land resources through:

- i. Promotion of non-timber forest products (NTFPs) such as honey, gum Arabic, and medicinal plants
- ii. Development of climate-smart value chains and market linkages
- iii. Support for off-farm income generation, particularly targeting women and youth
- iv. Skills development programs aligned with emerging economic opportunities

Survey respondents showed strong interest in several of these interventions. When asked about willingness to adopt different adaptation strategies, the highest interest was expressed for improved water harvesting (86.2%), drought-resistant crop varieties (84.9%), and small-scale irrigation (79.3%). Interest in alternative energy solutions was moderate (58.1% for improved cookstoves, 51.7% for solar alternatives), suggesting the need for demonstration and awareness-raising in this area.

Policy Recommendations and Institutional Frameworks

Addressing desertification and drought effectively requires supportive policy environments and institutional arrangements. Based on the findings of this study, the following policy recommendations are proposed for Katsina, Kebbi, and Zamfara states:

Integrated Land Use Planning:

- i. Develop and implement participatory land use plans at local government levels that recognize ecological conditions and traditional land management systems
- ii. Establish clear demarcation of grazing reserves, forest reserves, and agricultural zones to reduce resource conflicts
- iii. Integrate climate change projections into spatial planning to anticipate vulnerability transitions

Cross-Sectoral Coordination:

- i. Establish state-level desertification coordinating bodies with representation from agriculture, environment, water, energy, and planning departments
- ii. Develop joint programs between forestry departments and energy agencies to address fuelwood challenges comprehensively
- iii. Align drought management strategies with broader development planning

Economic Incentives and Financial Mechanisms:

- i. Implement payment for ecosystem services (PES) schemes to reward sustainable land management
- ii. Develop weather-indexed insurance products for smallholder farmers
- iii. Establish revolving funds for adoption of climate-smart technologies
- iv. Redirect agricultural subsidies toward sustainable practices

Monitoring and Knowledge Management:

- i. Strengthen early warning systems for drought and desertification
- ii. Establish participatory monitoring networks involving local communities



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- iii. Document and disseminate traditional ecological knowledge relevant to drought and land management
- iv. Create knowledge-sharing platforms across the three states

Capacity Development:

- i. Strengthen extension services with a focus on climate-resilient practices
- ii. Develop training programs for local government officials on integrated natural resource management
- iii. Support farmer-to-farmer learning networks and demonstration sites
- iv. Incorporate climate change and sustainable land management into educational curricula

Ultimately, addressing desertification and drought in Katsina, Kebbi, and Zamfara states requires a multi-faceted approach that combines ecological restoration, sustainable land management, alternative livelihoods, and enabling policies. By integrating scientific understanding with local knowledge and addressing both immediate symptoms and underlying drivers, there is potential to reverse degradation trends and build resilience to climate change in this vulnerable region. The findings from the 1020 survey respondents across the three states provide a solid foundation for developing locally appropriate and socially acceptable interventions that can effectively combat these interlinked challenges.

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Effect Of Project-Based Learning Approach on Problem-Solving Ability in Mathematics among Secondary School Students in Kebbi Metropolis, Kebbi State, Nigeria

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Abstract

Mathematics problem-solving skills is a vital component of 21st-century learning; however, many students face challenges due to lack of engagement and limited real-life application of concepts. Effect of Project-Based Learning approach on Problem-solving ability in Mathematics among Secondary School Students in Kebbi Metropolis, Kebbi State. A quasi-experimental design was employed, involving some selected secondary schools within Kebbi metropolis, where the experimental group was exposed to PBL strategies, while the control group received traditional instruction. Data were collected using the Mathematics Problem-Solving Skills Test (MPST) and analyzed using descriptive and inferential statistics. The MPST was validated by experts in mathematics education and measurement and evaluation. Similarly, the reliability of the MPST was determined using the Kuder-Richardson 20 (KR-20) formula, where a reliability coefficient of 0.75 was achieved. The findings revealed that students taught through PBL demonstrated significantly improved problem-solving abilities compared to those in the conventional learning environment. The study concludes that project-based learning is an effective instructional method for promoting mathematical thinking and recommends its integration into the mathematics curriculum in secondary schools.

Keyword: Project-Based learning, Mathematics, students

Introduction

Education systems globally are increasingly recognizing the importance of equipping students with skills that transcend rote learning, particularly in challenging subjects such as mathematics. Among various pedagogical approaches, Project-Based Learning (PBL) has been grabbing attention as an interesting way to boost critical thinking and tackle real-life problems by actually getting students involved. In the context of secondary education within Kebbi Metropolis, where academic performance in mathematics often reflects broader educational challenges, the integration of PBL presents an opportunity to transform traditional learning experiences. PBL pushes learners to work together, chat more freely and use mathematics in a down-to-earth way, which often helps ideas stick better than the usual textbook methods. The ongoing problems with mathematics achievement clearly point to the need for inventive, student-centred strategies that also help build a better teacher-student bond (Nonyelum et al., 2022). Generally speaking, these kinds of shifts go hand in hand with global trends that aim to prepare students for the tricky challenges of modern professions (Awe et al., 2022).

Strategies that pull students into genuinely meaningful tasks have been getting quite a lot of attention these days, as they generally lift how much is learnt. Project-Based Learning, known simply as PBL, is a student-centred method where pupils tackle real-life problems in a collaborative setting, which often tweaks their understanding and builds up unexpected skills. Unlike traditional instruction, PBL emphasizes inquiry, critical thinking, and the practical application of knowledge, positioning the teacher as a facilitator who guides rather than directs the learning process (Sweet et



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al., 2024). This pedagogical model integrates multiple disciplines and encourages students to develop problem-solving abilities by working on authentic challenges, often utilizing technology and teamwork (Kartini et al., 2020). This approach also mixes real-life situations into everyday learning, which often boosts motivation and sharpens problem-solving skills. When it comes to mathematics, for example, students can work through tricky problems that mirror everyday life, helping them to think analytically and apply their knowledge practically (Yulianto et al., 2024).

In contemporary education, fostering competencies that extend beyond rote memorization has become imperative, particularly in mathematics, where critical thinking and creativity are essential. Problem-solving skills serve as a cornerstone for mathematical understanding and are crucial for students to apply theoretical knowledge to real-world scenarios. The relevance of these skills is underscored by the growing need for entrepreneurship competencies, as emphasized in the Indonesian educational context, where project-based learning (PBL) models not only enhance problem-solving but also nurture creativity and collaboration among students (Putriyani et al., 2023). Furthermore, developing effective problem-solving skills in mathematics is crucial not only for academic success but also for fostering critical thinking and analytical abilities that students carry into other disciplines and real-life situations. In secondary education, especially within contexts such as Kebbi Metropolis, emphasizing problem-solving will equip learners to navigate complex concepts and apply mathematical reasoning to practical challenges. Through enhanced problem-solving competence, students become better prepared for higher education and the workforce, which increasingly demand innovative and adaptable thinkers. Moreover, fostering these skills via pedagogical approaches like project-based learning can bridge gaps in understanding and engagement, as positive student-teacher relationships and interactive learning environments significantly influence academic performance in mathematics (Nonyelum et al., 2022).

Kebbi Metropolis, in Kebbi State, is located in northwestern Nigeria and presents a distinctive educational environment shaped by socio-economic challenges and infrastructural limitations that directly affect teaching and learning outcomes in secondary schools. Predominantly agrarian, the local economy faces issues such as unemployment and poverty, which impact students' access to quality educational resources and support systems for subjects like mathematics (Obaniyi et al., 2023). Furthermore, amidst efforts to enhance academic performance, sustaining effective educational practices remains difficult due to inconsistent policies and infrastructural deficits (Nonyelum et al., 2022). Although, there is a talk of fresh global partnerships and some inventive classroom ideas taken from other developing regions, which suggest that well-tailored educational tweaks might really spark student engagement and help build crucial skills (Fariana et al., 2024).

Mathematics plays a critical role in fostering logical reasoning, analytical thinking, and real-world problem-solving abilities among learners. Despite its importance, secondary school students in many regions, including Kebbi Metropolis, often struggle with applying mathematical concepts to solve problems effectively. Traditional teaching methods, which emphasize rote learning and memorization, have been found inadequate in addressing these challenges. In recent years, project-based learning (PBL) has emerged as a dynamic instructional strategy that places students at the center of the learning process, promoting active engagement, collaboration, and critical thinking. This review examines existing literature on the influence of PBL on mathematics problem-solving skills among secondary school students.



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Project-Based Learning (PBL)

Project-Based Learning (PBL) is a student-centered pedagogy that engages learners in exploring real-world problems and challenges through sustained inquiry. According to Krajcik and Shin (2021), PBL organizes learning around projects that require critical thinking, collaboration, creativity, and communication to produce meaningful outcomes. Students are not merely passive recipients of information; they actively construct knowledge through exploration and problem-solving. Project-based learning is an instructional approach where students gain knowledge and skills by working over an extended period to investigate and respond to a complex question, problem, or challenge (Thomas, 2020). Unlike traditional instruction, PBL emphasizes student autonomy, inquiry, collaboration, and real-world relevance (Bell, 2010). Past research hints that when teachers and students share lively, genuine exchanges, a bit of clear talk paired with mutual respect academic success tends to follow, with students showing more interest and performing better in mathematics (Nonyelum et al., 2022). There's also a growing international buzz about the benefits of learning by doing; these collaborative, hands-on approaches naturally echo PBL since they get everyone involved in tackling real-life problems (Krajcik & Shin, 2021).

Problem Solving Skills

Problem-solving skills refer to an individual's ability to identify, analyze, and resolve problems efficiently and effectively. According to Jonassen (2020), problem-solving involves cognitive processes such as information gathering, pattern recognition, critical thinking, reasoning, decision-making, and reflection. In mathematics education, these skills are essential for applying knowledge to unfamiliar or complex problems (Polya, 2021). Additionally, problem-solving in mathematics refers to the process of applying mathematical concepts and techniques to find solutions to unfamiliar and complex problems. According to Polya (1945), effective problem-solving requires four stages: understanding the problem, devising a plan, carrying out the plan, and reviewing the solution. Research shows that developing problem-solving skills is crucial for students to succeed in mathematics and other STEM-related disciplines (Schoenfeld, 1992). Tadesse and Gillies (2020) further explain that problem-solving is a dynamic and iterative process involving defining the problem, generating possible solutions, evaluating and selecting solutions, and implementing and reflecting on the solution.

Various studies have pointed out many challenges students struggle with; issues like low engagement and a lack of hands-on experience often mean they can't quite apply mathematical ideas as they should. Some evidence suggests that our usual, traditional teaching ways just don't spark that critical thinking needed these days, which is why, in most cases, teachers have begun turning to fresh methods such as project-based learning. Collaborative, context-driven learning environments, for instance, seem to offer a boost to the mental flexibility required for tackling problems. Research from a range of educational settings generally emphasizes that teacher support, having the right resources, and genuine student motivation all play a big part in developing these skills. Yet, even with these insights, certain gaps remain, Kebbi Metropolis, for instance, where such approaches aren't widely in use; this clearly calls for further exploration into how project-based learning might better address local educational challenges and ultimately lift students' mathematics problem-solving abilities (Awe et al., 2022; Obaniyi et al., 2023; Nonyelum et al., 2022).



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Project-Based Learning Implementation in Mathematics Classrooms

Many studies showed that project-based learning (PBL) in mathematics classes not only boosts students' critical thinking but helps them solve difficult and challenging problems too. Research has often pointed out that relating lessons to everyday life is an approach that makes learning more active, deepens understanding and pulls learners into the subject a bit more (Shandy et al., 2024). In areas like Technical and Vocational Education and Training, PBL has been seen to tackle issues with weak mathematics skills by stressing practical, industry-matched abilities, which generally lets learners handle complicated challenges (NorHakim et al., 2025). Still, getting PBL right isn't without its bumps; many educators note that gaps in teacher training and a shortage of resources mean there's a pressing need for better institutional backing and more regular professional development (Erbasan et al., 2022). Equally, managing PBL well usually involves a mix of careful planning, hands-on implementation, and follow-up evaluations, all of which help create learning experiences that really stick and build skills over time (Arsjad et al., 2023). Altogether, these insights suggest that PBL might well transform the teaching of maths by nurturing genuine problem-solving abilities that are crucial for both academic and professional success.

Traditional Approach and Project-Based Learning Approach on Students Performance

Teaching methods have a big impact on how students get involved and build skills, particularly in mathematics. Traditional learning approaches, often characterized by direct instruction and textbook reliance, have been shown to yield comparable academic outcomes to project-based learning (PBL) in some contexts, as evidenced by the lack of significant differences in achievement between cohorts in social studies assessments (Jatisunda et al., 2024). However, PBL's emphasis on experiential, student-centred inquiry presents distinct advantages in cultivating deeper problem-solving abilities, reflected in improved mathematics self-concept and enhanced performance post-intervention (Carter, 2024) (Brown et al., 2021). Moreover, beyond academic achievement, PBL fosters practical skills integration and real-world application, as demonstrated in business education settings where PBL outperforms traditional methods in developing complex managerial competencies (Suharsono et al., 2025). Thus, while traditional methods may sustain foundational knowledge, PBL appears more effective in promoting active problem-solving and higher-order thinking skills essential for mathematical proficiency, supporting its increasing adoption in modern curricula aimed at addressing contemporary educational demands

Statement of the Research Problem

Despite the recognized importance of problem-solving skills in mathematics, many secondary school students in Kebbi continue to struggle with effectively applying mathematical concepts to real-world situations. This persistent difficulty is partly due to traditional teaching methods that emphasize rote memorization and passive learning rather than active engagement. Consequently, students often lack the critical thinking and analytical skills necessary for successful problem-solving, which negatively impacts both their academic performance and confidence in mathematics. Furthermore, the inadequacy of instructional approaches tailored to diverse learning styles contributes to this challenge, limiting students' opportunities to internalize mathematical reasoning in meaningful ways. The introduction of project-based learning (PBL), which encourages hands-on, collaborative exploration of complex problems, presents a potential solution to bridge this gap. However, its adoption and impact within the context of Kebbi Metropolis remain insufficiently examined, warranting thorough investigation to determine whether PBL can effectively enhance students' problem-solving skills in mathematics.



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Objectives of the study

The following objectives were set to guide the study:

- i. Compare the problem-solving skills of students taught using project-based learning and those taught using conventional teaching methods among secondary schools in Kebbi metropolis.
- ii. Determine the differences in problem-solving skills of male and female students taught using a project-based learning approach among secondary schools in Kebbi metropolis.

Research Questions

The following research questions were generated for the study:

1. Is there a significant difference in the problem-solving skills of students taught using project-based learning and those taught using conventional teaching methods among secondary schools in Kebbi metropolis?
2. Is there a significant difference in problem-solving skills of male and female students taught using a project-based learning approach among secondary schools in Kebbi metropolis?

Hypotheses

H₀₁: There is no significant difference in the problem-solving skills of students taught using project-based learning and those taught using conventional teaching methods among secondary schools in Kebbi metropolis.

H₀₂: There is no significant difference in the problem-solving skills of male and female students taught using a project-based learning approach among secondary schools in the Kebbi metropolis.

Methodology

This study adopted a quasi-experimental pre-test and post-test control group design. This design is appropriate because it allows the researcher to measure the effect of Project-Based Learning (PBL) on students' problem-solving skills in mathematics by comparing experimental and control groups over time (Creswell & Creswell, 2018). The experimental group were exposed to mathematics instruction through project-based learning strategies, while the control group received conventional lecture-based teaching. The population for this study comprises all Senior Secondary School II (SS2) students offering Mathematics in secondary schools within Kebbi Metropolis. There are 43 public senior secondary schools with total of 6,738 students from which 3,752 are male and 2,986 are female distributed within the state. The population of SS2 students is 2,730, consisting of both male and female students. These students are chosen because they have foundational mathematical knowledge and are preparing for external examinations, making them ideal for studying problem-solving development. A sample of 100 students was selected using multi-stage sampling techniques. Purposive sampling was employed to select secondary schools with similar characteristics, and random sampling was adopted to select participants into two groups: the experimental group (50 students) and the control group (50 students). This approach ensures generalizability while controlling for biases. Two major instruments were employed for the data collection: the Mathematics Problem-Solving Skills Test (MPST), which was self-designed by the researcher, a standardized test containing both structured and open-ended mathematics problems extracted from SS2 curriculum topics, and the Project-Based Learning Implementation Guide, which is a structured guide for researchers to ensure uniform delivery of PBL strategies during the intervention period for the experimental group. The MPST was validated by experts in mathematics education and measurement and evaluation. Similarly, the reliability of the MPST was determined using the Kuder-Richardson 20 (KR-20) formula, where a reliability coefficient of 0.75 was achieved and considered high enough

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for the study. A pre-test on MPST was first administered to both groups to establish baseline problem-solving skill levels, then the experimental group received mathematics instruction through project-based learning tasks for 8 weeks, and the control group continued with traditional lecture-based teaching for the same topics and period. At the end of 8 weeks, the MPST was administered again to both groups, monitoring observations and periodic check-ins to ensure fidelity of the PBL intervention. The data collected was analyzed using descriptive statistics (mean, standard deviation) to describe students' performance and inferential statistics, that is, independent samples t-tests, to compare mean differences between experimental and control groups. Statistical analysis was conducted at a 0.05 level of significance.

Presentation of Results

Research Question 1:

Is there a significant difference in the problem-solving skills of students taught using project-based learning and those taught using conventional teaching methods among secondary schools in Kebbi metropolis?

Table 1: Descriptive Statistics of Problem-Solving Skills Scores for Experimental and Control groups

Group	N	Mean	Standard Deviation
Experimental (PBL)	50	78.35	6.42
Control (Conventional)	50	65.27	7.15

Table 1 indicated that the mean score of students in the experimental group ($M = 78.35$, $SD = 6.42$) is higher than that of the control group ($M = 65.27$, $SD = 7.15$). This suggests that project-based learning had a positive effect on students' problem-solving skills in mathematics.

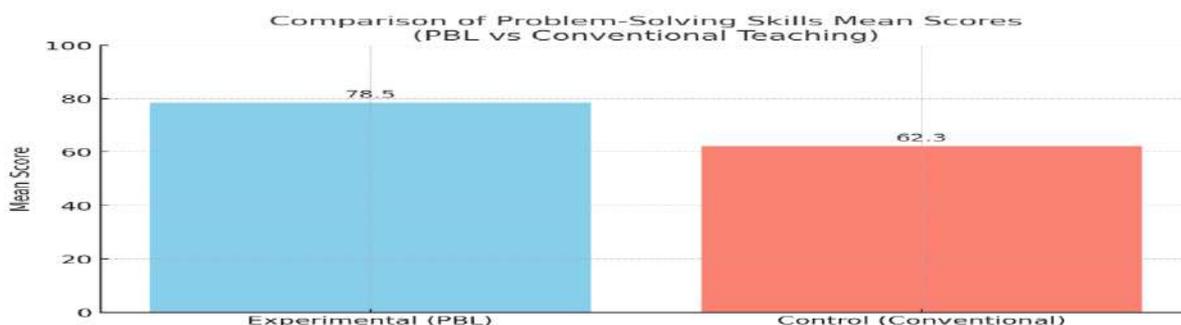
Hypothesis one

H_0 : There is no significant effect of project-based learning on secondary school students' problem-solving skills in mathematics among secondary schools in Kebbi metropolis.

Table 2: Independent Samples t-test on Problem-Solving Skills Scores

Group Comparison	t	df	p-value	Mean Difference	Decision
Experimental vs Control	9.45	98	< .001	13.08	Reject

The independent samples t-test indicated a statistically significant difference in problem-solving skills between the experimental group and the control group, $t(95) = 9.45$, $p < .001$. The mean difference was 13.08 points, favoring the experimental group. Since the p-value (.000) is less than the 0.05 level of significance, the null hypothesis (H_0) is rejected. This implies that project-based learning had a significant positive effect on students' problem-solving skills in mathematics.



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Figure 1: Comparison of Problem-Solving Skills Mean Scores

Figure 1 above visually displays the comparison between the two groups. depicting the experimental group (PBL) scored much higher on problem-solving skills compared to the control group (conventional teaching).

Research Question 2:

Is there a significant difference in the problem-solving skills of male and female students taught using the project-based learning approach among secondary schools in Kebbi Metropolis?

Table 3: Descriptive Statistics for Problem-Solving Skills Scores by Gender (PBL)

Gender	N	Mean	Standard Deviation
Male	28	79.20	6.10
Female	22	77.40	6.78

As shown in Table 3, male students (M = 79.20, SD = 6.10) had a slightly higher mean score than female students (M = 77.40, SD = 6.78) in problem-solving skills under the project-based learning approach.

Hypothesis two

H₀₂: There is no significant difference in the problem-solving skills of male and female students taught using a project-based learning approach among secondary schools in the Kebbi metropolis.

Table 4: Independent Samples t-Test Results for Gender Differences (PBL Group)

Gender Comparison	t	df	p-value	Mean Difference	Decision
Male vs Female (PBL Group)	1.04	48	.304	1.80	Not Rejected

The result in table 4 of the independent samples t-test indicated no statistically significant difference in problem-solving skills between male and female students, $t(46) = 1.04, p = .304$. The mean difference was 1.80 points in favor of male students. Therefore, since the p-value (.304) is greater than the 0.05 level of significance, we do not reject the null hypothesis (H₀).

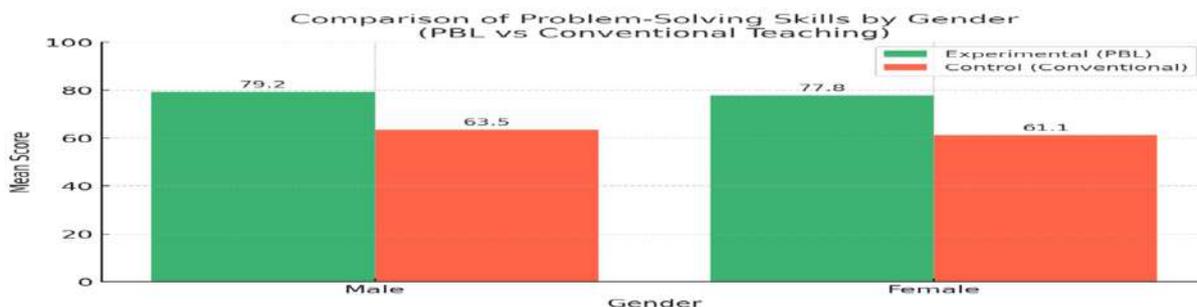


Figure 2: Comparison of Problem-Solving Skills by Gender

Figure 2 shows the comparison of problem-solving skills between male and female students in both the Project-Based Learning (PBL) group and the Conventional Teaching group, indicating

Discussion of Findings

The present study investigated the effectiveness of Project-Based Learning (PBL) in enhancing problem-solving skills among secondary school students in Kebbi Metropolis. The results revealed that students who were taught using the PBL approach significantly outperformed those taught using conventional teaching methods in mathematics problem-solving tasks. Furthermore, gender differences in performance under PBL were not statistically significant. These findings align with



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previous studies emphasizing the effectiveness of PBL in promoting critical thinking, creativity, and real-world problem-solving abilities. For instance, Fariana et al. (2024) asserted that PBL provides learners with opportunities to actively construct knowledge by engaging in authentic, meaningful tasks. Similarly, research by Faulkner et al. (2020) highlighted that PBL fosters deeper learning and improves student motivation, leading to better academic outcomes in complex domains such as mathematics.

In this study, the mean score of the experimental group (PBL) was notably higher than that of the control group (conventional method), suggesting that involving students in hands-on, project-driven activities helped them to better understand and apply mathematical concepts. This supports the findings of Musa, Mufti, Latiff, and Amin (2021), who found that PBL enhances mathematical reasoning and problem-solving competencies more effectively than traditional approaches. Moreover, the absence of a significant gender difference in problem-solving skills among students taught with PBL suggests that the approach is equitable and beneficial across genders. This result resonates with research conducted by Kokotsaki, Menzies, and Wiggins (2022), which indicated that PBL can minimize achievement gaps by providing an inclusive learning environment where all learners actively participate and engage.

Conclusion

This study investigated the role of Project-Based Learning (PBL) in enhancing problem-solving skills among secondary school students in Kebbi Metropolis. The findings revealed that students exposed to PBL demonstrated significantly better problem-solving abilities compared to those taught using conventional instructional methods. Additionally, no significant gender difference was observed among students taught through the PBL approach, indicating that it is an effective and inclusive teaching strategy for all learners. The results underscore the potential of PBL to improve mathematical thinking by actively engaging students in meaningful, real-world tasks that foster critical and creative thinking. These outcomes support previous research emphasizing the effectiveness of learner-centered approaches in developing higher-order cognitive skills essential for academic and lifelong success. At Kebbi Metropolis, research into project-based learning (PBL) in mathematics has revealed some really encouraging signs. This style of teaching pushes students to get stuck into problems in a hands-on way, making them think on their own and work together, which is crucial for those tricky mathematical challenges.

Recommendations

Based on the findings and conclusions of this study, the following recommendations are made:

- i. Curriculum developers should embed project-based learning strategies into the mathematics curriculum to promote students' critical thinking, collaboration, and problem-solving skills.
- ii. Regular workshops and training programmes should be organized to equip mathematics teachers with the knowledge and skills needed to effectively design and implement project-based learning activities in their classrooms.
- iii. Teachers should maintain gender-sensitive practices in the implementation of PBL to ensure that both male and female students are equally engaged and supported in problem-solving activities.
- iv. Policymakers and educational authorities should create policies that encourage innovative instructional methods like PBL, particularly in STEM education, to foster skills relevant to the 21st-century workforce.



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- v. Teachers should incorporate formative assessment and continuous feedback mechanisms within PBL activities to monitor student progress and address challenges promptly.

Limitation and Further Research

Despite its contributions, this study was limited to selected secondary schools in Kebbi Metropolis, which may affect the generalizability of the findings. Future studies could extend to a larger and more diverse sample across different regions. Additionally, longitudinal studies could be conducted to investigate the long-term effects of PBL on mathematical problem-solving and other higher-order thinking skills.

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An Overview of the Emergence of Open Access Publishing: Government Policies and the Academia in Africa

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Abstract

The movement towards Open Access began in earnest in the late 20th century, driven by technological advancements in the digital realm and growing dissatisfaction with the traditional publishing model. This Paper explores Open Access (OA) publishing and how it facilitates free access to research materials, ensuring wider dissemination of knowledge. It includes several models such as Gold Open Access where Articles are freely available on the publisher's site, with authors or their institutions typically paying an Article Processing Charge (APC) to cover publication costs. Green Open Access where Authors self-archive their work in repositories after an embargo period, allowing free public access to preprints or post-prints and Diamond (Platinum) Open Access with both publishing and access free for authors and readers, often seen in smaller or community-driven journals. In Africa, initiatives like African Journals Online (AJOL) and the African Open Access and Scholarly Communication Coalition (AASCC) have driven OA adoption. These platforms provide access to African scholarly journals, promoting visibility and international collaboration. National policies in countries like South Africa, Uganda, and Nigeria also support OA, though challenges like inadequate infrastructure and the financial burden of APCs persist. Academics play a critical role in OA, publishing in OA journals, advocating for policies, creating repositories, and educating others. Their involvement enhances the accessibility, visibility, and impact of African research, fostering collaboration and supporting local development. Despite the advantages, barriers such as APC costs, limited infrastructure, and concerns about the prestige of OA journals hinder broader adoption in Africa. However, OA remains a vital tool for enhancing access to knowledge, particularly in low-resource settings, and contributes to Africa's scientific and social development. While open access is transforming scholarly publishing by making research more accessible and reducing barriers to knowledge, challenges related to cost and quality control remain.

Keyword: Open Access Publishing, Emergence, Academia, Africa

Introduction

Open Access (OA) is a publishing model that allows scholarly works, particularly research articles, to be made available online without access barriers such as paywalls or subscription fees. The primary goal of OA is to ensure that academic knowledge is freely accessible to all, thereby promoting the dissemination of research findings, accelerating innovation, and enhancing public access to scientific information (Suber, 2012). The movement towards Open Access began in earnest in the late 20th century, driven by technological advancements in the digital realm and growing dissatisfaction with the traditional publishing model. The first formal discussions on OA emerged in the 1990s, fueled by the rapid growth of the internet. Early proponents of OA, argued that publicly funded research should be freely available to the public (Harnad, 1995). The *Budapest Open Access Initiative* (BOAI) in 2002 was a landmark in the history of OA, outlining important principles for the movement and urging the global adoption of open access to scholarly literature. BOAI called for the transition of academic publishing towards OA models to ensure the free and universal availability of scholarly knowledge (Suber, 2012).



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Progressively, the development of Green OA and Gold OA was bolstered by policy changes in the early 2000s. Notably, in 2003, the U.S. National Institutes of Health (NIH) mandated that all research funded by the agency be made freely available in PubMed Central (PMCID) after a 12-month embargo (Suber, 2012). The OA movement gained significant momentum with the rise of online repositories, such as arXiv (founded in 1991), which made preprints in physics and other disciplines freely available to the public (Laakso et al., 2011). In recent years, the momentum for OA has continued to grow, especially in Europe and the United States, where public funding agencies and academic institutions have pushed for the adoption of OA mandates. The European Union introduced OA policies through Horizon 2020 and later Horizon Europe, mandating OA publication for all research outputs resulting from EU-funded projects (European Commission, 2022). One of the most significant recent milestones was the launch of Plan S in 2018 by a coalition of research funders in Europe. Plan S aims to make all publicly funded research OA by 2025, requiring that researchers publish only in compliant open access journals or repositories (Coalition, 2024).

In Africa, the OA movement has been steadily growing, particularly with the support of international organizations, governmental policies, and local initiatives. One of the important drivers of OA in Africa has been the push for increased access to knowledge, especially given the financial barriers that hinder researchers' ability to publish in high-cost subscription-based journals. African researchers and institutions have increasingly embraced OA as a means to make their research accessible to global audiences (Okpechi, 2019). For instance, African Journals Online (AJOL) is a leading platform that supports OA by providing a repository of African scholarly journals. (Ogunyomi & Adeboye, 2017). Various African countries have taken steps to promote OA through national policies. For example, in 2018, the South African Department of Science and Innovation (DSI) introduced an OA policy that mandates OA publication of research funded by the government (Wagner, 2020). This policy was part of a broader strategy to improve the visibility of South African research and increase the country's scientific impact globally. Similarly, the Ugandan National Council for Science and Technology (UNCST) has also introduced policies to support OA and open data as part of the country's development agenda (Olatunji & Ojo, 2021). Academics in Africa also play a central role in the Open Access (OA) movement, as they are both the producers and the primary consumers of scholarly research. Their involvement is crucial to the success of OA, influencing its adoption, development, and sustainability. Academics' engagement with OA is multifaceted, encompassing research publication, advocacy, and the creation of OA resources.

Collaborations and Global Support for Open Access in Africa

The promotion of Open Access (OA) publishing in Africa has been significantly influenced by both regional collaborations and international support. While Africa faces unique challenges in terms of research funding, infrastructure, and access to academic resources, various collaborative initiatives and global partnerships have played a crucial role in advancing the OA movement across the continent. These collaborations have facilitated the development of OA infrastructure, increased access to scientific knowledge, and promoted African research on the global stage. International collaborations have played a crucial role in advancing OA in Africa. Initiatives like OpenAIRE and The Digital Library of Information on African Research (DLIR) are working to improve the accessibility of African research. OpenAIRE, for instance, is an EU-funded project that helps African researchers manage and disseminate research data through OA (Githaiga & Mgaiwa, 2021). Moreover, African participation in global OA initiatives, such as Plan S (which mandates that publicly funded research



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must be openly accessible), continues to grow, even though some African countries face challenges in meeting these requirements due to limited funding and infrastructure (Coalition, 2024).

Some of the international initiatives directed towards supporting OA in Africa, to bridge the gaps in resources and infrastructure include but not limited to:

The OpenAIRE Project: OpenAIRE is a European Union-funded initiative that supports researchers, institutions, and funders in adopting OA practices. While OpenAIRE primarily operates within Europe, it has expanded its support to include African researchers, offering tools, training, and guidance on managing open research data and ensuring that research funded by European and African organizations is publicly accessible (Githaiga & Mgaiwa, 2021). OpenAIRE's support has been instrumental in increasing the visibility of African research, particularly in terms of open data and publications.

The Research4Life Initiative: Research4Life, a partnership between the World Health Organization (WHO), FAO, and other stakeholders, provides free access to academic journals and e-books in low- and middle-income countries, including many in Africa. This initiative has played a vital role in improving access to scientific literature for African researchers, enabling them to stay abreast of global developments without facing financial barriers (Muthusamy et al., 2017). Research4Life's OA model helps to alleviate the knowledge gap in Africa by offering free access to academic resources across disciplines, particularly health and agriculture.

The Global Open Access Fund: Initiatives such as the Open Society Foundations (OSF) support OA publishing in Africa through funding opportunities that promote the development of local OA journals and platforms. By providing financial backing, the OSF has helped reduce the reliance on expensive APCs, which are often a barrier for African researchers (Tennant et al., 2016). These collaborations ensure that African researchers are not excluded from the OA movement due to financial limitations.

Types of Open Access (OA)

1. **Gold Open Access:** In this model, articles are made freely available on the publisher's website, and the author or their institution often pays an Article Processing Charge (APC) to cover the costs of publication (Tennant et al., 2016). This method has gained popularity in recent years as a way to ensure that academic research is accessible without the need for readers to pay for access.
2. **Green Open Access:** This model involves authors self-archiving their work in institutional or subject-specific repositories, often after an embargo period (Suber, 2012). While the final version of a paper may not always be freely available immediately, the preprint or postprint versions can still be accessed by the public.
3. **Diamond Open Access:** Also referred to as "Platinum" OA, this model does not require authors to pay any charges and ensures that both publishing and access are free to both authors and readers. This model is more commonly seen in smaller journals or initiatives, especially in developing countries (McKiernan et al., 2016).

African-Led Collaborative Initiation for Open Access Publishing

While global support is essential, African-led initiatives have also been important in fostering OA growth within the continent. Some of the most significant African-led initiatives include:

African Journals Online (AJOL): AJOL is one of the largest and most well-established OA platforms in Africa. It provides free access to thousands of African scholarly journals, enabling African researchers to share their work with the global community (Ogunyomi & Adebayo, 2017). AJOL is a



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vital resource for African academics, facilitating the dissemination of research from a variety of fields such as health, agriculture, and education. AJOL's success highlights the importance of regionally based OA initiatives in making African research more visible and accessible to the world.

The African Open Access and Scholarly Communication Coalition (AASCC): The AASCC is a network of African academic institutions and organizations aimed at promoting OA publishing practices across the continent. Through the AASCC, African universities and research institutions collaborate on building the infrastructure needed for OA, as well as advocating for policies that ensure the accessibility of African research outputs (Mabweazara et al., 2017). This coalition has been instrumental in raising awareness about the importance of OA for Africa's development, especially as African scholarship faces challenges in being published in high-impact, international journals. Several African-led open access journals have been established to address local needs and provide a platform for African scholars. Journals such as African Health Sciences, African Journal of Information and Communication Technology, and The Pan African Medical Journal contribute significantly to the body of open access research in Africa. These journals play an important role in increasing the global visibility of African research, especially in fields like health, agriculture, and technology, which are critical to the continent's development (Jambo & Mulikita, 2021).

The South African Research Chair Initiative (SARChI): In South Africa, the government has supported OA through the SARChI program, which encourages researchers to publish their work in OA journals. This initiative not only facilitates the dissemination of South African research but also creates opportunities for collaboration with other African and international researchers. SARChI is part of a broader national strategy to increase the visibility and global competitiveness of South African science (Wagner, 2020).

Institutional Support and National Policies

Several African governments and institutions have adopted policies that facilitate OA publishing. The most notable policies include:

South Africa's National Open Access Policy: In 2018, the South African Department of Science and Innovation (DSI) introduced a national OA policy. This policy mandates that all publicly funded research outputs be made available through OA platforms. The policy is supported by both local institutions and international collaborations, such as those with the South African National Research Foundation (NRF), which encourages the publication of research in OA journals and repositories (Wagner, 2020). The policy is part of a broader government initiative to enhance South Africa's participation in global research and increase the impact of locally produced knowledge.

Uganda's National Open Access Policy: Uganda has also made strides in promoting OA through the creation of a national OA policy. The policy encourages researchers to publish in OA journals and archives their research outputs in OA repositories. This policy is part of Uganda's broader scientific development agenda, which seeks to improve the accessibility and global competitiveness of the country's research (Olatunji & Ojo, 2021).

Adoption of the National Open Access Policy (NOAP) in Nigeria

In 2012, Nigeria made an important move towards OA by adopting the National Open Access Policy (NOAP), which was developed by the National Information Technology Development Agency (NITDA) in collaboration with the National Universities Commission (NUC) and other stakeholders in the academic and research communities (Adeyemo et al., 2021). The policy aims to ensure that publicly funded research is freely accessible to the public, thereby supporting the development of a knowledge-based economy. The main goals of the Nigerian OA policy are to promote access to



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scientific information, encourage the dissemination of Nigerian research globally, and improve the quality of higher education and research by making research findings available to a wider audience. The policy specifically mandates that all publicly funded research outputs in Nigeria be made available through OA platforms, with a focus on repositories, journals, and institutional archives (NITDA, 2012).

Implementation of the Open Access Policy

The Nigerian Open Access Policy encourages universities and research institutions to establish institutional repositories where scholars can deposit their research publications and data. The policy also calls for the creation of national digital archives for research outputs to ensure long-term preservation and access. Furthermore, it urges Nigerian researchers to publish in OA journals and make their work available through international OA platforms (NITDA, 2012). The policy promotes the use of Creative Commons licenses to ensure that works are freely available but still protected by copyright laws. This is crucial for allowing researchers to share their findings while maintaining control over how their work is used. However, the implementation of the policy has faced challenges, including limited infrastructure, inadequate funding, and a lack of awareness and training on OA practices among researchers and institutions (Ajadi & Okunoye, 2019).

Government and Institutional Support

Nigerian universities and research institutions have begun to embrace OA through the establishment of institutional repositories. For instance, Ahmadu Bello University (ABU), University of Nigeria, Nsukka (UNN), Obafemi Awolowo University (OAU), and University of Lagos (UNILAG) have set up institutional repositories that allow their researchers to deposit their works in OA formats (Okpechi, 2019). These repositories are essential in improving access to the research produced by Nigerian scholars. Additionally, the Nigerian Digital Library initiative, supported by the government, has worked to create a centralized platform for accessing OA materials from Nigerian academic institutions. The government has also been involved in international OA initiatives, collaborating with organizations like Research4Life, which offers free access to scholarly literature for researchers in low- and middle-income countries (Olatunji & Ojo, 2021).

Objectives of Nigeria's Open Access Policy

The primary objectives of Nigeria's OA policy include but not limited to:

Increasing access to research outputs: The policy aims to make publicly funded research freely accessible to researchers, policymakers, and the public, addressing the gap caused by the high subscription fees of academic journals (Muthusamy et al., 2017).

Promoting scientific collaboration: By making research more accessible, Nigeria's OA policy seeks to foster collaborations between local researchers and international scholars, enhancing the quality and impact of Nigerian research on the global stage (Olumide & Akinmoladun, 2020).

Encouraging the use of Institutional Repositories (IR): The policy encourages universities and research institutions to set up institutional repositories to house research outputs, ensuring long-term access to these materials (Olatunji & Ojo, 2021).

Enhancing the development of Nigerian knowledge and innovation: Open Access is viewed as a tool to stimulate innovation and support the development of a knowledge-based economy by making research outcomes more widely available for use by industries, policymakers, and other stakeholders (Olumide & Akinmoladun, 2020).

Challenges in Implementing the Open Access Policy in Nigeria

Despite these efforts, Nigeria faces several challenges in fully implementing the OA policy. A major challenge is the digital divide, where many institutions lack the technical infrastructure needed to



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manage OA repositories effectively. The lack of stable internet access in some regions further hampers the ability to disseminate research freely (Tennant et al., 2016). Additionally, the financial burden of Article Processing Charges (APCs) remains a significant barrier, as many Nigerian researchers cannot afford the fees required to publish in high-quality OA journals (Björk, 2017). Another challenge is the low awareness of OA among researchers. Many Nigerian scholars still prefer to publish in traditional subscription-based journals, which are often considered more prestigious. This is partly due to a lack of training and awareness about the benefits and procedures of OA publishing (Okpechi, 2019).

Role of the Academia in the Open Access (OA) Publishing

Academics play a central role in the Open Access (OA) movement, as they are both the producers and the primary consumers of scholarly research. Their involvement is crucial to the success of OA, influencing its adoption, development, and sustainability. Academics' engagement with OA is multifaceted, encompassing research publication, advocacy, and the creation of OA resources.

1. Publishing in Open Access Journals

One of the most significant ways academics in Africa contribute to OA is by publishing their research in OA journals. By choosing to submit their work to OA platforms, academics ensure that their research is freely accessible to a global audience. This is particularly important for scholars in lower-income regions, where subscription-based journals may be inaccessible due to financial constraints (Björk, 2017). Academics also help improve the visibility of OA by contributing to the growing body of open literature. This not only increases the reach and impact of their own work but also advances global scientific knowledge, facilitating collaboration across borders (Piwowar et al., 2018). In some cases, authors may need to pay Article Processing Charges (APCs) to publish in high-quality OA journals, and thus, their involvement is critical in navigating the balance between access and cost (Tennant et al., 2016).

2. Advocacy and Policy Influence

Academics also play a vital role in advocating for open access policies at institutional, national, and international levels. Many scholars participate in policy development by advocating for OA mandates within their universities, research organizations, or through their involvement in governmental bodies (Suber, 2012). For example, in the United States, scholars have been instrumental in promoting policies like the National Institutes of Health (NIH) Public Access Policy, which requires that publicly funded research be made freely available within 12 months of publication (Suber, 2012). Moreover, academics contribute to global OA initiatives, such as Plan S, which aims to make all publicly funded research OA by 2025 (Coalition S, 2024). Their participation in such initiatives often involves publishing in OA-compliant journals and ensuring their research adheres to the OA principles outlined in such policies.

3. Creation of Open Access Repositories

In addition to publishing in OA journals, academics contribute to OA by creating and maintaining institutional or disciplinary repositories. These repositories host research outputs and make them freely accessible to the public. Scholars frequently deposit their works, including preprints, datasets, and final published articles, in these repositories. Such repositories have become increasingly important for preserving and disseminating research outputs in a variety of fields. Notable examples include arXiv for physics and mathematics and PubMed Central for life sciences (Laakso et al., 2011). By archiving their work in repositories, academics also enable broader dissemination and reuse of research data, thus promoting collaboration and accelerating scientific discovery. They also help address issues of long-term accessibility and visibility for scholarly work (McKiernan et al., 2016).

4. Educating and Training Others



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Academics also play a crucial role in educating and training other researchers, students, and early-career scholars about the benefits of OA and how to engage with the movement. Many universities offer training sessions, workshops, and seminars on OA publishing practices, the use of institutional repositories, and the legal aspects of OA licenses, such as Creative Commons (Houghton et al., 2010). In this way, scholars help foster a new generation of researchers who are aware of and equipped to participate in OA publishing, contributing to the long-term sustainability of the OA movement.

5. Peer Review and Editorial Roles

Academics contribute to OA not only as authors but also as peer reviewers and editorial board members of OA journals. Peer review is a cornerstone of scholarly publishing, and the involvement of academics in this process ensures that research published in OA journals meets high academic and scientific standards (Björk, 2017). By acting as editors and reviewers for OA journals, scholars help uphold the quality of OA research outputs, ensuring that these platforms maintain academic rigor and credibility.

Barriers to Open Access in Africa

Despite these contributions, academics face several challenges in fully embracing OA.

1. One important issue is the financial burden of APCs, particularly in disciplines with high publication costs (Björk, 2017).
2. Some researchers may face resistance to OA due to concerns about the perceived prestige or impact of OA journals, especially when compared to traditional subscription-based journals (Tennant et al., 2016).
3. Lack of infrastructure and awareness about OA policies, particularly in low-income regions, may hinder the broader adoption of OA publishing. The absence of an established publishing infrastructure for OA in many African countries has also contributed to the underrepresentation of African research in global scientific discourse (Mabweazara et al., 2017).
4. Some critics argue that open access publication does not guarantee quality control, as the demand for APCs may incentivize publishers to accept articles without sufficient peer review (Björk, 2017).

Benefits of Open Access Publishing

The benefits of open access are numerous, including increased visibility, citation potential, and broader impact of research findings.

1. Increased Access to Knowledge

One of the primary benefits of OA publishing in Africa is the increased access to scholarly articles, data, and research findings. In many African countries, access to subscription-based journals is often limited due to high costs, and universities or research institutions may not have the resources to purchase these materials (Mawdsley, 2018). OA allows researchers, students, and practitioners to access high-quality research for free, thus democratizing knowledge and addressing the information gap that exists between African countries and developed regions (Mthembu, 2019). By making research outputs publicly accessible, OA promotes educational advancement, research innovation, and informed decision-making in sectors such as health, agriculture, and education.

For instance, Research4Life, a global initiative providing free access to scholarly publications for institutions in low-income countries, has been pivotal in helping African researchers gain access to academic journals that would otherwise be out of reach (Muthusamy et al., 2017). OA initiatives such as this have provided much-needed resources to African researchers, facilitating the growth of local knowledge bases.

2. Promoting Research Visibility and Impact



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OA publishing plays a crucial role in enhancing the visibility and impact of African research on the global stage. African researchers often face challenges in publishing in high-impact journals due to limited financial resources, as many OA journals charge high Article Processing Charges (APCs). Despite this, publishing in OA journals increases the likelihood that research will be widely disseminated and cited (Ajadi & Okunoye, 2019). The global visibility that OA provides helps elevate African scholarship, making it more accessible to international collaborators, policymakers, and the public. For example, in fields like public health, agriculture, and environmental science, African research can address unique local challenges and offer solutions relevant to other regions of the Global South (Chawinga, 2017). By publishing in OA platforms, African scholars contribute to global knowledge pools and demonstrate the relevance of their work on global issues, such as climate change, health crises, and poverty reduction.

3. Facilitating Collaboration and Knowledge Sharing

OA fosters increased collaboration among researchers across borders. By removing the financial and access barriers to scholarly information, OA enables African researchers to collaborate more easily with peers from other continents. This is particularly important for Africa, where cross-border collaboration can play a significant role in solving problems that transcend national boundaries, such as diseases, environmental issues, and social development challenges. Global initiatives like OpenAIRE and the African Journals Online (AJOL) platform facilitate this kind of cross-border collaboration by providing repositories where African researchers can share their findings with the global community (Githaiga & Mgaiwa, 2021). Collaboration is essential for accelerating the pace of scientific discovery and fostering innovation, and OA serves as a bridge that connects researchers from different regions and disciplines.

4. Supporting Local Capacity Building and Policy Development

OA publishing not only helps disseminate research but also plays a crucial role in building local research capacity in Africa. As researchers are encouraged to deposit their work in OA repositories, the academic community becomes more engaged in the practice of sharing knowledge and creating open resources. African universities, research institutions, and libraries are increasingly adopting OA practices, and this has contributed to capacity building in the region (Mabweazara et al., 2017).

In addition, OA provides opportunities for local scholars to develop policies that address regional challenges, as the freely accessible research can inform national and international policymaking. For instance, governments and development agencies in Africa can use OA resources to shape policies related to public health, agriculture, and environmental sustainability. By making research more accessible, OA empowers African institutions to create evidence-based policies that support the continent's development goals.

5. Cost Efficiency and Sustainability

OA publishing offers a more cost-effective alternative to traditional subscription-based publishing models, which are often financially burdensome for African researchers and institutions. With many African universities and research bodies operating under budget constraints, OA offers an affordable solution that allows them to access and contribute to academic literature without the need for expensive subscriptions (Björk, 2017). Moreover, OA can contribute to the sustainability of the African research ecosystem by ensuring that local researchers and institutions are not dependent on external publishers. By developing regional OA journals and repositories, African countries can maintain control over the dissemination of their research outputs, keeping the process more localized and self-sustaining (Muthusamy et al., 2017). OA publishing can also reduce the costs associated



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with physical distribution and access, making research outputs more accessible even in remote areas with limited infrastructure.

6. Contribution to Social and Economic Development

OA publishing can also support Africa's social and economic development by providing access to research that directly addresses local issues. African research often focuses on topics such as poverty alleviation, sustainable agriculture, and improving healthcare systems issues that are vital for the continent's progress. By promoting the accessibility of such research through OA, the findings can be used by policymakers, NGOs, and other stakeholders working to implement solutions in these areas. In sectors like health, for example, open access to research on diseases such as malaria, HIV/AIDS, and tuberculosis can help improve healthcare policies and interventions. Similarly, OA publishing of agricultural research can support smallholder farmers by providing them with knowledge on sustainable farming practices and new technologies that could improve food security (Chawinga, 2017).

7. Overcoming Infrastructure Barriers

Although Africa faces challenges in terms of internet connectivity and technological infrastructure, OA publishing can help bridge some of these gaps. Many African institutions are adopting institutional repositories and digital libraries to store and share research outputs. Initiatives like the **Open African Innovation Research (OpenAIR)** program are working to build the infrastructure required to support OA publishing across the continent. These efforts help address the technological limitations faced by African researchers and improve their ability to participate in the global knowledge economy (Okpechi, 2019).

Conclusion

while open access is transforming scholarly publishing by making research more accessible and reducing barriers to knowledge, challenges related to cost and quality control remain. Nonetheless, the drive toward open access continues to grow, driven by evolving policies and a collective effort to make knowledge available to everyone, everywhere. Open Access publishing is an essential tool for fostering research visibility, collaboration, and capacity building in Africa. It promotes equity in access to knowledge, supports sustainable development, and empowers local researchers to contribute to global scientific discourse. However, challenges such as financial constraints, infrastructure issues, and limited awareness remain. Despite these obstacles, the continued growth of OA publishing in Africa holds significant potential for enhancing the region's research landscape and fostering long-term social and economic development.

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Students' Preference for Admission into Federal Colleges of Education (Technical) in Nigeria: Voluntary Choice or Systemic Coercion?

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Abstract

This study investigates the degree to which student admission into Nigeria's Federal Colleges of Education (Technical) is informed by personal preference or imposed by systemic, familial, and policy constraints. Using a mixed-methods design, data were gathered from 470 students across ten federal technical colleges situated in Nigeria's six geopolitical zones, alongside qualitative interviews with staff and student groups. Descriptive statistics, logistic regression, thematic coding, and chi-square analyses were conducted to uncover patterns of voluntary versus coerced enrollment. Findings revealed that only 25.53% of students selected their institution and program based on personal interest, while a majority were directed by policy placement (53.19%) or family pressure (21.28%). The study introduces the concept of Systemic Admission Coercion (SAC), capturing the interplay of socioeconomic hardship, regulatory frameworks, and cultural norms that stifle student agency. Policy recommendations include reforms to the JAMB Central Admissions Processing System (CAPS), enhanced career counselling, and national rebranding of technical teacher education. This research provides a policy-relevant framework for addressing structural injustice embedded in Nigeria's education access mechanisms.

Keywords: Student preference, systemic coercion, technical education, tertiary admission, Nigeria

Introduction

In modern education systems, student autonomy in choosing a preferred academic institution or course of study is a cornerstone of motivation, academic engagement, and eventual career fulfillment. Yet in many developing countries—including Nigeria—this autonomy is routinely distorted by structural constraints beyond the control of the student. Despite rising enrollment figures and expanded access to higher education, few students genuinely exercise self-directed decision-making in the schooling process. Technical colleges in Nigeria, especially the Federal Colleges of Education (Technical), are intended to play a vital role in producing technically competent teachers for secondary and vocational education. These institutions are strategically situated across Nigeria's six geopolitical zones and designed to reinforce national goals related to technological transformation, skills acquisition, and teacher supply in STEM-related subjects. However, anecdotal and administrative evidence consistently indicates that these colleges are not first-choice institutions for most students. Observations suggest that students are often “redirected” to these institutions through a combination of policy-imposed placement, failure to meet university requirements, socioeconomic pressures, and family mandates. These insights demand a deeper investigation into what drives student enrollment in Nigeria's Colleges of Education (Technical): Are these students choosing their paths, or are they victims of a coercive educational structure?

The broader implication lies not just in understanding individual stories of displacement, but in assessing the capacity of these colleges to fulfill their mandates when the majority of enrollees arrived with no intrinsic motivation. Fault lines are clearly visible across gender, class, and regional divisions. Northern students, for instance, often face cultural constraints, while students from economically disadvantaged backgrounds have limited options other than accepting local, less



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prestigious offers. By exploring these dynamics empirically, this paper engages with a growing body of work that calls for deconstructing the illusion of “choice” in African education systems. It focuses on answering the core questions: To what degree is student choice autonomous? What are the dominant predictors of coerced admission? And how can Nigeria’s technical education institutions fulfill their mandate when the majority of students are socialized into disengagement?

Literature Review

Student Choice and Structural Constraints

Globally, scholars have long examined student choice as a culturally and economically mediated decision process. Cabrera and La Nasa (2000) argue that even in developed contexts, choice is rarely free—a student’s socioeconomic background, informational access, and familial expectations filter their options long before application deadlines. Ball et al. (1996) and Reay (2004) extend this argument, highlighting how class-based inequalities translate into misaligned opportunity structures, particularly visible in college and program selection. In Nigeria, access to higher education is determined not only by academic ability or exam performance but by a combination of regulatory entitlements (e.g., catchment area, quota systems), economic realities, and cultural lineage. Oni (2024) finds that more than 60% of students accepted into non-university institutions viewed the placement as temporary or undesired. As Adamu and Yusuf (2021) explain, the JAMB-controlled Central Admissions Processing System (CAPS) frequently redirects students into institutions with open slots, many of which include Colleges of Education (Technical).

Cultural Pressures and Parental Influence

Family dynamics, especially parental influence, play a profound role in shaping students’ educational paths in Nigeria. In households where education is both an economic investment and status symbol, parents often predetermine choices based on job security, religious acceptability, or community expectations (Adebayo & Alabi, 2021; Chukwuemeka & Igbokwe, 2022). For female students in conservative regions of Northern Nigeria, cultural norms may restrict higher education options and impose locally acceptable career choices, irrespective of personal interest (Ibrahim & Usman, 2020).

Socioeconomic Disadvantage and Compelled Acceptance

Olajide and Olagunju (2019) show that many students from low-income households accept admission into nearby technical institutions due to unaffordability of university location, tuition, and transportation. This reality aligns with studies by Callender (2018) and Obi and Yusuf (2024) who assert that affordability, rather than aspiration, is the dominant determinant of educational choice in low-income communities. In effect, institutional proximity becomes a proxy for “choice,” particularly where little or no financial aid opportunities exist.

Technical Education: Status, Perception, and Mismatch

Despite its critical role in national development, technical education in Nigeria continues to suffer from perception problems. It is frequently dismissed as a fallback option for students who could not meet university entrance thresholds. Waziri and Dabo (2025) describe this as the “academic recycling tier,” where motivation and preparation are often suboptimal. In their study, Eze and Nwankwo (2022) found that students placed in technical education programmes without initial interest reported lower satisfaction and higher dropout tendencies. This stigma undermines national policy goals, including the use of Colleges of Education (Technical) to stem youth unemployment and promote self-reliance through entrepreneurship. The alignment is compromised when the pathway into these institutions is itself the result of misalignment or social compulsion.



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Theoretical Framework

To conceptualize and analyze the study's findings, two theoretical lenses are employed: Social Reproduction Theory (Bourdieu) and Human Capital Theory, with a new model 'Systemic Admission Coercion' (SAC) developed from the study's empirical base.

Social Reproduction Theory

Pierre Bourdieu's theory of Social Reproduction posits that education systems often maintain, rather than disrupt, class hierarchy and privilege by embedding dominant group norms into formal schooling (Bourdieu & Passeron, 1977). In this view, institutional structures reward those already socialized into the "habitus" of academia and devalue those whose social backgrounds do not align. Technical education institutions draw disproportionately from under-resourced regions and schools, reinforcing their function as residual pathways. In the Nigerian case, this dynamic is visible in how students from poorer backgrounds and remote regions are overrepresented in institutions that are undervalued socially and economically. The very process of being redirected by CAPS or coerced by family into these institutions is a manifestation of institutionalized inequality masquerading as educational fairness.

Human Capital Theory

Human Capital Theory articulates education as a strategic investment whose outputs are measurable in skills, productivity, and economic growth (Becker, 1993; Schultz, 1961). However, in Nigeria's context of structural inequality, the theory's application becomes ambiguous. Students, particularly those from lower-income homes, are often forced to accept marginal returns on their educational investment—selecting less rewarding or misaligned education paths due to affordability and access factors (Ibrahim & Usman, 2020; Ukaigwe, 2021). This mismatch undermines both the promise of education as human capital and its utility in eradicating poverty. Enrolling in a programme by coercion minimizes student engagement and increases the likelihood of negative academic outcomes.

Systemic Admission Coercion (SAC)

To integrate the empirical reality observed in this study, the concept of Systemic Admission Coercion (SAC) is introduced. SAC refers to a multidimensional phenomenon where centralized policy systems (e.g., UTME placements), socio-economic hardship, and sociocultural expectations constrain students' ability to choose an academic path that aligns with their interest, aptitude, or life goals. Distinct from overt coercion, SAC operates subtly and systemically, compelling students to accept suboptimal education outcomes that their social position preordains. This model reflects both macro-level policy decisions and micro-level family decisions that remove volition—even when choice mechanisms (such as application portals or counselling services) are said to exist. SAC thus becomes a powerful diagnostic lens to reevaluate access, equity, and engagement in Nigeria's technical teacher education system.

Methodology

Research Design

This study employed a convergent parallel mixed-methods design, integrating quantitative and qualitative data to understand the extent and nature of systemic coercion in students' admissions into Colleges of Education (Technical) in Nigeria. A mixed-methods approach was considered appropriate, as it enables the validation and expansion of quantitative trends through in-depth contextual exploration (Creswell & Creswell, 2018). Quantitative data provided generalizable patterns, while qualitative inputs from focus group discussions (FGDs) and in-depth interviews (IDIs) enriched the findings through narrative evidence.



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Population and Sampling

The population for this study comprised students admitted between 2020 and 2025 into Federal Colleges of Education (Technical) across Nigeria's six geopolitical zones. These institutions were deliberately chosen because they are federally regulated, centrally admitted through JAMB/UTME, and offer similar technical education programmes under the National Commission for Colleges of Education (NCCE) mandate. A total of ten Federal Colleges of Education (Technical) in Nigeria were selected as research sites. These institutions reflect diverse regional locations and admission practices, thereby increasing the representativeness of the findings. Using stratified random sampling, a total of 470 students were selected from first- and second-year cohorts across these colleges. Stratification was based on institution, gender, admission mode, and department, ensuring a diversified sample suitable for statistical analysis. Additionally, 20 focus group discussions (FGDs) and 10 in-depth interviews (IDIs) involving faculty heads and admission officers were conducted across the institutions.

Data Collection Instruments

Quantitative Instrument; A structured questionnaire was used, divided into five major sections: Section A: Demographic Information; Section B: Personal Interest and Motivation; Section C: Parental/Guardian Influence; Section D: Socioeconomic Constraints and Section E: Policy-Directed Placement Experiences. Items were measured on a 5-point Likert scale, ranging from *Strongly Disagree (1)* to *Strongly Agree (5)*. The questionnaire was pilot-tested, and internal consistency reliability measured using Cronbach's Alpha yielded $\alpha = 0.87$, indicating a high level of reliability (Nunnally, 1978).

Qualitative Instruments

Focus Group Discussions (FGDs) and In-Depth Interviews (IDIs) explored students' admission decision journeys, perceptions of technical education, and reflections on systemic barriers. FGD participants were grouped by gender and year of study to capture intersecting perspectives. Interview guides for staff focused on institutional policies, student motivation, and observed patterns of student engagement over time.

Data Analysis Methods

Quantitative data were analyzed using SPSS Version 25. Techniques included: Descriptive statistics (mean, SD, frequencies); Chi-square tests to assess relationships between variables (e.g., gender vs. admission type); Independent sample *t*-tests to explore group differences; Logistic regression analysis to identify predictors of voluntary vs. coerced admission and Cross-tabulations to reveal demographic variations. Qualitative data were transcribed and analyzed using Braun and Clarke's (2006) thematic analysis technique. Codes were collated into themes and examined for alignment with the quantitative findings, allowing for deep triangulation between modalities.

Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of the Federal College of Education (Technical), Gusau. Informed consent was secured from all participants, and anonymity and confidentiality were upheld. Participation was entirely voluntary, and students were allowed to skip questions or withdraw at any time.

Presentation of Results

Student Admission Type Distribution

Table 1 summarizes the mode of admission into technical colleges as reported by the 470 respondents.



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Admission Type	Frequency	Percentage
Voluntary (self-chosen)	120	25.53%
Parental Influence	100	21.28%
Policy/Quota Placement	250	53.19%
Total	470	100%

Source: Field Survey (2025).

The data show that the majority of students (approximately three-quarters or 74.47%) did not choose their colleges voluntarily. Instead, they were either allocated through policy or directed by parents or guardians. Only one in four students exercised agency in the admission process.

Mean Ratings of Admission Influence Factors

Students rated the extent to which different factors influenced their admission decision.

Factor	Mean Score (Max = 5.00)
Policy Placement	4.35
Parental/Guardian Pressure	4.10
Socioeconomic Constraints	4.00
Perceived Employability	3.60
Personal Interest/Motivation	3.45

Source: Field Survey (2025).

External factors—policy, parents, and poverty—emerged as dominant influences over intrinsic factors like personal interest or employability awareness.

Logistic Regression Analysis

To predict factors influencing the probability of voluntary admission, logistic regression was performed.

Predictor	β	p-value	Exp(β)	Interpretation
Personal Interest	1.82	<0.01	6.18	Strong positive influence
Parental Influence	-1.12	0.03	0.33	Significant negative influence
Socioeconomic Constraints	-0.87	0.04	0.42	Significant negative influence
Policy Placement	-0.35	0.47	ns	Not significant individually
Perceived Employability	0.54	0.13	ns	Not statistically significant

Source: Field Survey (2025).

The strongest predictor for voluntary choice was personal interest, which increased the odds six times more than other variables. However, parental pressure and financial hardship were significant negative predictors, reducing the likelihood of free choice by 67% and 58%, respectively.

Cross-Tabulations and Chi-Square Tests

Chi-square analyses found significant associations at $p < 0.05$: Region vs. Admission Type: Students from northern colleges more likely to be coerced than southern counterparts; Gender vs. Admission Type: Female students less likely to have made voluntary choices; Family Economic Background vs. Admission Type: Students from low-income families were overrepresented in policy-driven and parentally influenced admissions

Thematic Findings from FGDs and IDIs

Theme 1: Parental and Cultural Direction

“My father insisted I should learn metalwork because it’s good for handwork and I’ll get a job teaching quickly. I wanted to study Business Administration.” – Female, FCE (T) Gusau



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Theme 2: Financial Constraints as a Limiting Agent

"I applied to university, but we couldn't afford the fees. My parents chose the college of education close to home." – Male, FCE (T) Gombe

Theme 3: Policy-Induced Rerouting

"I didn't pick this college. I got a text from JAMB that I had a space here. I didn't know what technical education was before coming." – Female, FCE (T) Omoku

Students expressed feelings of surprise, resignation, or indifference at being reallocated by JAMB, having missed cutoff marks for more preferred programmes.

Summary of Key Findings

1. Autonomous choice is the minority experience: Only 25.53% independently selected their programme.
2. Systemic forces dominate student paths: Policy placement and socioeconomic factors significantly outweigh personal interest in shaping admissions.
3. Parental authority plays a coercive role, especially in rural contexts and female education.
4. CAPS and JAMB's redistribution mechanisms, while aimed at equity, inadvertently reroute students away from interest-aligned destinations.

Discussion of Findings

This study reveals a clear disconnect between student aspirations and their realized educational pathways, demonstrating that a significant portion of students in Nigeria's Colleges of Education (Technical) do not enroll out of personal choice. Instead, structural constraints—including policy-driven placement, financial hardship, and familial influence—function as coercive mechanisms that restrict student autonomy. These findings directly validate concerns raised in the literature about the illusion of choice in Nigerian higher education (Ajayi & Ayodele, 2023; Obi & Yusuf, 2024).

The conjunction of quantitative patterns and qualitative narratives indicates that the majority of students are subject to a process best described as systemic admission coercion. Despite appearing to have multiple institutional options through the JAMB Unified Tertiary Matriculation Examination (UTME), in reality, students—particularly from poor or rural backgrounds—navigate a closed loop of affordability, access limits, and parental control, which ultimately predetermines their college placements.

The Illusion of Choice in a Constrained System

Analysis of logistic regression indicates that personal interest as a predictor of voluntary admission is statistically powerful, increasing the odds of choosing one's college by over six times ($\text{Exp}\beta = 6.18$). However, this choice is often overridden by parental instruction or systemic allocation. Over half of the respondents (53.19%) were allocated to their institutions through JAMB's reallocation protocols such as CAPS—an automated system ostensibly created for fairness, yet one that potentially undermines student aspirations. This finding resonates with Bourdieu's theory of *social reproduction*, which argues that education systems tend to preserve social stratification by channeling less-privileged groups into lower-status institutions (Bourdieu & Passeron, 1977). In the Nigerian context, Federal Colleges of Education (Technical), though important to national manpower development in STEM education, are devalued due to negative perceptions, low entry thresholds, and misunderstood career pathways—turning them into destinations of last resort, rather than authentic platforms for skill empowerment.

Parental Coercion and Familial Expectations



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Findings also show that more than one in five students (21.28%) reported parentally driven programme decisions. In some communities, students—especially daughters—are discouraged from attending universities far from home or are directed into “non-prestigious, but safe” careers like teaching (Chukwuemeka & Igbokwe, 2022). Such pressures, though sometimes well-intentioned, deprive students of identity exploration and self-efficacy, critical factors for academic persistence and meaningful career formation (Bosah, 2020; Adebayo & Alabi, 2021). Qualitative data support this claim. Several female participants described how their fathers or uncles submitted application forms on their behalf, choosing local technical colleges for cost or religious reasons. Here, the role of family shifts from that of support system to coercive agent. The overlap between economic paternalism (sponsorship) and cultural patriarchy (decision-making) places students—particularly female and low-income youths—at even greater disadvantage.

Economic Hardship as Structural Barrier

Socioeconomic constraints featured prominently in both the regression and thematic analyses. Roughly 40% of students shared that they would have pursued university education or professional programmes like engineering or medicine, if not for cost. Instead, they settled for local technical colleges, which were more affordable and often allowed them to live at home. This finding reflects the outcomes of studies by Ibrahim and Usman (2020) and Olajide and Olagunju (2019), which show that university attendance in Nigeria is increasingly shaped by wealth levels rather than academic ability. From a Human Capital Theory lens, this means that less-privileged students are denied the opportunity to make optimal investments in their future earnings—a process that confirms Schultz's (1961) argument that educational returns favor those with the resources to freely choose high-value inputs.

Gendered and Regional Dimensions of Coercion

Chi-square testing and qualitative accounts suggest that female students and those from northern institutions were more likely to report external influences and lack of choice. This is not merely a cultural observation but signals deep systemic bias rooted in regionally uneven resources and gender-based access challenges (UNESCO, 2022; CLEEN Foundation, 2021). Girls, in particular, are often forced to accept programs in safe or proximate institutions, further reducing their national mobility and vocational competitiveness. This intersectionality aligns with global research on gender, class, and educational (dis)empowerment, particularly in contexts where policy distracts from lived inequality (Reay, 2004). Without deliberate inclusion policies and funding strategies, such disparities will likely persist, further entrenching inequality in technical education enrolment and outcomes.

Towards a Theory of Systemic Admission Coercion (SAC)

In synthesizing these findings, this paper proposes Systemic Admission Coercion (SAC) as a useful conceptual framework for interpreting coerced enrollment into non-preferred institutions in developing country contexts. SAC occurs not through brute force, but through (i) Structural placement systems like CAPS (ii) Socioeconomic limitations (iii) Cultural norms that prioritize family control over student preference (iv) Misaligned career information and poor counselling.

As a model, SAC helps to describe hidden coercion in formal equality. It stresses the ways in which “access to education” can still be stratified by income, region, and social capital—even under computerized, merit-based admission policies. This complicates dominant narratives that link rising enrollment with rising choice and satisfaction. It also calls for a more nuanced design of admission strategies that balance merit, equity, and motivation.

Conclusion



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This study examined the underlying factors influencing student admission into Federal Colleges of Education (Technical) and found that a substantial portion of respondents enrolled as a result of coercive, rather than voluntary, conditions. Only one in four students chose their institution based on genuine interest. The others were pushed by family, filtered by financial hardship, or passively reallocated through policy structures. The implications of such coercion are immense. When students do not begin their higher education journey with interest or informed understanding, the likelihood of disengagement, underperformance, and attrition increases. Technical education, which is already under pressure to feed Nigeria's innovation and workforce pipelines, suffers reputational damage as a result. It becomes a "landing space" for redirected students rather than a deliberate career destination. This study, therefore, calls for a multi-tiered intervention: one that retools admission policies, strengthens institutional guidance services, reinvests in public information about technical education, and—most importantly—restores agency to the student. Only such systemic change can prevent coercion from becoming normalized as the entry point into technical education.

Policy and Practice Recommendations

In light of the findings and the emergent theory of Systemic Admission Coercion (SAC), the following policy and practice recommendations are proposed to restore autonomy in student educational pathways and enhance the status of technical teacher education in Nigeria.

Reform JAMB Policy and CAPS Automation

The current implementation of the Central Admissions Processing System (CAPS) by JAMB, while ostensibly equitable, compromises student choice through algorithmic reallocation. To ensure that students maintain autonomy over their academic futures:

- i. The process should integrate a mandatory student verification stage before final placement into alternative institutions.
- ii. Reallocations should be preceded by counselling prompts and career advisory messages through the JAMB portal.
- iii. Applicants must have a viable opt-out or deferment mechanism if reallocation does not match their preferences, rather than having to accept by default.

Such reforms would create a more student-centered admissions system.

Institutional Empowerment and Orientation Programs

Colleges of Education (Technical) must intervene at the institutional level to reduce student detachment and attrition resulting from coerced placements. Recommended actions include:

- i. Onboarding and induction programmes focused on career awareness, pedagogy in STEM, and graduate success stories.
- ii. The use of counselling units to identify and support students who express dissatisfaction upon admission.
- iii. Setting up student mentorship networks to foster vocational identity among first-year students.

Improve Access to Career Counselling in Secondary Schools

The roots of coercive admission often begin in senior secondary school, where inadequate guidance counsellors and a lack of access to career information lead to uninformed choices.

- i. Federal and state governments should mandate career counselling integration into school curriculum from SS1.
- ii. Teachers, alumni from technical colleges, and workplace mentors should conduct career visibility seminars in secondary schools annually.



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- iii. Parents and guardians must be included in these orientation programs to ensure joint decision-making supports the student's interest.

Tackling the Economic Roots of Coercion

Scholarship and financial aid policies should be redesigned for inclusiveness:

- i. Introduce needs-based scholarships specific to students choosing technical education paths.
- ii. Provide mobility stipends to low-income students who receive placement far from home but wish to pursue programmes that match their interest.
- iii. Colleges should form partnerships with industry to create internship opportunities that allow students to gain early work experience while studying, reducing dropout risks linked to financial stress.

Rebranding Technical Education

Finally, the negative perception of technical education must be tactically addressed:

- i. Launch a National TVET Campaign, showcasing the role of technical educators in digital skills, green economy jobs, STEM entrepreneurship, and innovation.
- ii. Upgrade facilities and learning environments in technical colleges to inspire confidence, improve performance, and represent 21st-century learning experiences.
- iii. Institutional leaders should be empowered to advocate for more visibility of technical colleges in educational planning and national skill development frameworks.

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Impact of Digital-Learning Tools on ... Mahmud, W. Et. al. (2025)

Impact of Digital-Learning Tools on Knowledge and Skills Acquisition in Agricultural Sciences among Secondary School Students in Northern Nigeria

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Abstract

This study investigated the impact of digital learning tools on agricultural knowledge acquisition and skill development among secondary school students in rural Northern Nigeria. A quasi-experimental design was employed, involving 100 students from rural secondary schools, divided into an experimental group (using digital learning tools) and a control group (using traditional teaching methods). Data were collected through pre- and post-tests on agricultural knowledge, practical skill assessments, and a retention test. The results revealed that students in the experimental group demonstrated significant improvements in both agricultural knowledge (mean increase of 30.60 points) and practical skills (mean increase of 31.65 points), compared to the control group, which showed smaller gains. The experimental group also exhibited better retention of knowledge, with a minimal decrease in post-test scores. Despite these positive outcomes, challenges such as lack of electricity, poor internet connectivity, inadequate teacher training, and limited access to digital devices were identified as major barriers to the effective implementation of digital tools. The findings suggest that digital learning tools significantly enhance agricultural education by improving students' knowledge, skills, and retention, but highlight the need for addressing infrastructural and training-related challenges to maximize their effectiveness. This study underscores the importance of integrating technology into agricultural education, particularly in rural settings, to bridge educational gaps and foster sustainable agricultural development.

Keywords: digital learning tools, agricultural education, knowledge acquisition, skill development

Introduction

Agriculture remains the backbone of Northern Nigeria's economy, providing livelihoods for the majority of its population and contributing significantly to food security and national economic growth. According to the Food and Agriculture Organization (FAO, 2022), the agricultural sector accounts for approximately 25% of Nigeria's GDP, with Northern Nigeria playing a pivotal role due to its vast arable land and favourable climatic conditions for the cultivation of crops such as millet, sorghum, rice, and maize. Despite its potential, agricultural productivity in the region has been hindered by outdated farming techniques, limited access to modern tools, and insufficient knowledge transfer to younger generations. Education, particularly at the secondary school level, is critical for equipping students with the knowledge and skills needed to adopt innovative agricultural practices and technologies that can transform the sector. Studies by Oladipo et al. (2023) emphasize that effective agricultural education can foster a new generation of skilled farmers and entrepreneurs,



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thereby driving rural development and economic sustainability. However, teaching agriculture in rural schools across Northern Nigeria faces numerous challenges, which threaten the quality and relevance of agricultural education. Many schools lack basic infrastructure, such as laboratories and demonstration farms, which are essential for practical learning. Teachers often rely on outdated curricula and traditional teaching methods that fail to engage students or reflect the realities of modern agriculture. Additionally, rural schools frequently suffer from a shortage of qualified teachers, compounded by inadequate professional development opportunities (Adewale & Ibrahim, 2021). These challenges contribute to a growing disconnect between agricultural education and the practical needs of the sector, leaving students ill-prepared to address the pressing issues of food insecurity, climate change, and resource management.

In recent years, digital learning tools have emerged as a potential solution to bridge these gaps. Tools such as mobile apps, e-learning platforms, and virtual simulations offer innovative ways to deliver agricultural education, enabling students to acquire both theoretical knowledge and practical skills. Digital tools can provide access to up-to-date information on modern farming techniques, facilitate interactive and experiential learning, and overcome geographical barriers that limit access to quality education in rural areas. For example, a study by Nwosu et al. (2022) demonstrated that the use of mobile applications in agricultural training programs significantly improved knowledge retention and practical skills among participants. Despite these promising developments, the integration of digital tools into agricultural education in rural Northern Nigeria remains limited due to infrastructural challenges, such as unreliable electricity and internet connectivity, as well as resistance to change among educators and policymakers. This study seeks to explore the impact of digital learning tools on agricultural knowledge acquisition and skill development among secondary school students in rural areas of Northern Nigeria. This research aims to provide insights that can inform policies and practices for the integration of technology in agricultural education by addressing the barriers to effective agricultural education and examining the potential of digital tools to enhance learning outcomes. In doing so, it contributes to the broader goal of empowering rural communities and fostering sustainable agricultural development in the region.

Objectives of the Study

The study aims to investigate the impact of digital learning tools on agricultural knowledge acquisition and skill development among secondary school students in rural areas of Northern Nigeria. Specifically, the objectives are:

1. To determine the baseline agricultural knowledge and skills of secondary school students before the introduction of digital learning tools.
2. To evaluate the effect of digital learning tools on students' agricultural knowledge acquisition compared to traditional teaching methods.
3. To assess the impact of digital learning tools on students' practical agricultural skills development.
4. To examine the retention of agricultural knowledge among students taught using digital learning tools versus those taught using traditional methods.
5. To identify challenges associated with implementing digital learning tools in agricultural education in rural schools.

Research Questions

The following research questions guide the study:



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1. What is the baseline agricultural knowledge and skill level of secondary school students in rural Northern Nigeria before the introduction of digital learning tools?
2. How do digital learning tools affect students' agricultural knowledge acquisition compared to traditional teaching methods?
3. What is the impact of digital learning tools on the development of students' practical agricultural skills?
4. How does the retention of agricultural knowledge differ between students taught using digital learning tools and those taught using traditional methods?
5. What challenges are encountered in the implementation of digital learning tools in agricultural education in rural schools?

Literature Review

Theoretical Framework

This study is anchored on two complementary theories: the Technology Acceptance Model (TAM) and Constructivist Learning Theory, both of which provide a foundation for understanding the integration of digital learning tools in agricultural education. The Technology Acceptance Model (TAM), developed by Davis (1989), posits that two key factors—*perceived usefulness* and *perceived ease of use*—influence an individual's intention to adopt and use technology. In the context of this study, TAM explains how students and teachers in rural schools may perceive and adopt digital learning tools for agricultural education. For instance, if students find digital tools helpful in acquiring agricultural knowledge and easy to use, they are more likely to engage with them, leading to improved learning outcomes. Recent studies, such as that by Adetunji and Bello (2023), highlight the relevance of TAM in understanding the adoption of e-learning platforms in Sub-Saharan Africa, emphasizing the importance of addressing barriers like technological infrastructure and user training.

The Constructivist Learning Theory, rooted in the works of Piaget (1970) and Vygotsky (1978), emphasizes that learners construct knowledge actively through interaction with their environment and meaningful experiences. This theory underscores the importance of hands-on, experiential learning in agricultural education, which aligns with the use of digital tools such as virtual simulations, interactive videos, and mobile applications. By engaging students in interactive and practical learning activities, digital tools create opportunities for deeper understanding and skill development. For example, research by Nwosu et al. (2022) demonstrates that virtual farming simulations significantly enhance students' ability to apply theoretical knowledge to real-world agricultural practices. Together, TAM and Constructivist Learning Theory provide a robust framework for examining how digital tools can be effectively integrated into agricultural education. TAM offers insights into the factors influencing technology adoption, while Constructivist Learning Theory emphasizes the pedagogical benefits of interactive and experiential learning facilitated by digital tools. This dual perspective ensures a comprehensive understanding of both the technological and educational dimensions of the study.

Review of Related Studies

Digital tools have increasingly been recognized as transformative in enhancing educational outcomes across various disciplines, including agriculture. Research has shown that tools such as mobile applications, virtual simulations, and e-learning platforms can significantly improve knowledge acquisition, skill development, and student engagement in agricultural education. For instance, a study by Nwosu et al. (2022) found that mobile applications designed for agricultural training enhanced both theoretical knowledge and practical skills among rural students in Nigeria. These tools provided interactive and accessible learning experiences, enabling students to better



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understand modern farming techniques and crop management practices. Similarly, Olayemi and Adebayo (2021) explored the use of virtual reality (VR) simulations in agricultural education. Their findings revealed that VR tools allowed students to experience realistic farming scenarios, such as pest control and irrigation management, in a controlled and risk-free environment. This approach not only improved students' practical skills but also increased their interest in pursuing agriculture as a career. Furthermore, global studies, such as those by Patel et al. (2022), have highlighted the potential of e-learning platforms in agricultural extension services, noting that these platforms enable farmers and students to access up-to-date agricultural information and training remotely.

Despite these advancements, there is a noticeable gap in research focusing on the integration of digital tools in agricultural education within rural Northern Nigeria. Most studies in Nigeria have concentrated on urban or peri-urban settings, where access to technology and infrastructure is relatively better (Adewale & Ibrahim, 2021). Rural schools in Northern Nigeria face unique challenges, including limited access to electricity, poor internet connectivity, and a lack of digital literacy among teachers and students. These barriers have hindered the adoption and effective use of digital learning tools in agricultural education, leaving rural students at a disadvantage. Moreover, while studies such as that by Adetunji and Bello (2023) have examined the adoption of e-learning platforms in Sub-Saharan Africa, they often overlook the specific needs and contexts of agricultural education. For instance, rural students require tools tailored to their local agricultural practices, such as resources on drought-resistant crops and sustainable farming methods. This lack of localized and context-specific research underscores the need for studies that address the unique challenges and opportunities in integrating digital tools into agricultural education in rural Northern Nigeria.

Methodology

The study adopted a quasi-experimental design to evaluate the impact of digital learning tools on agricultural knowledge acquisition and skill development among secondary school students in rural areas of Northern Nigeria. The design involved two groups: an experimental group that received instruction using digital learning tools and a control group taught using traditional teaching methods. The population of the study comprised secondary school students in rural Northern Nigeria, with a sample size of 100 students selected using a multistage sampling technique. Schools were first stratified by location and accessibility to technology, and then students were randomly assigned to the experimental and control groups.

Data were collected using a combination of instruments, including a structured questionnaire, a knowledge test, and a practical skill assessment checklist. The instruments were validated by a panel of experts in agricultural education and instructional technology, ensuring content validity. Reliability was tested using Cronbach's alpha, yielding a coefficient of 0.85, indicating high internal consistency. The intervention involved teaching the experimental group with digital tools, such as mobile apps and virtual simulations, for six weeks, while the control group followed the standard curriculum. Data were analyzed using descriptive statistics to summarize demographic characteristics and inferential statistics, such as paired t-tests and ANCOVA, to compare knowledge acquisition, skill development, and retention between the two groups.

Presentation of Results

Research Question One:

What is the baseline agricultural knowledge and skill level of secondary school students in rural Northern Nigeria before the introduction of digital learning tools?



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Table 1: Baseline Agricultural Knowledge and Skill Level of Students

Variable	Mean	Standard Deviation	Interpretation
Agricultural Knowledge Score	45.20	8.35	Moderate
Practical Skill Score	40.75	7.90	Low

Note: Scores were based on a 100-point scale.

The results in Table 1 indicate that the baseline agricultural knowledge level of secondary school students in rural Northern Nigeria was moderate, with a mean score of 45.20 (SD = 8.35) out of 100. This suggests that while students possessed some foundational agricultural knowledge, there were significant gaps in their understanding. Similarly, the baseline practical skill level was low, with a mean score of 40.75 (SD = 7.90). These findings highlight the need for targeted interventions, such as the integration of digital learning tools, to improve both theoretical knowledge and practical agricultural skills among students in rural areas.

Research Question Two:

How do digital learning tools affect students’ agricultural knowledge acquisition compared to traditional teaching methods?

Table 2: Effect of Digital Learning Tools on Agricultural Knowledge Acquisition

Group	Pre-Test Mean	Post-Test Mean	Mean Difference	Standard Deviation	t-value	p-value
Experimental Group (Digital Tools)	45.20	75.80	30.60	6.45	15.23	<0.001
Control Group (Traditional Methods)	44.85	52.90	8.05	5.12	3.21	<0.01

Note: Scores were based on a 100-point scale.

As shown in Table 2, students in the experimental group, who were taught using digital learning tools, demonstrated a significant improvement in agricultural knowledge acquisition. The mean score for the experimental group increased from 45.20 (pre-test) to 75.80 (post-test), with a mean difference of 30.60 (SD = 6.45). This improvement was statistically significant (t = 15.23, p < 0.001), indicating that the digital tools had a substantial positive effect on students' knowledge. In contrast, the control group, which was taught using traditional methods, showed a smaller increase in knowledge, from a pre-test mean of 44.85 to a post-test mean of 52.90, with a mean difference of 8.05 (SD = 5.12). The difference was statistically significant (t = 3.21, p < 0.01), but much smaller compared to the experimental group. These results suggest that digital learning tools were more effective in enhancing agricultural knowledge acquisition than traditional teaching methods.

Research Question Three:

What is the impact of digital learning tools on the development of students’ practical agricultural skills?

Table 3: Impact of Digital Learning Tools on the Development of Practical Agricultural Skills

Group	Pre-Test Mean	Post-Test Mean	Mean Difference	Standard Deviation	t-value	p-value
Experimental Group (Digital Tools)	40.75	72.40	31.65	7.12	14.45	<0.001
Control Group (Traditional Methods)	40.50	50.60	10.10	5.68	4.28	<0.01

Note: Scores were based on a 100-point scale.

Table 3 illustrates the impact of digital learning tools on the development of practical agricultural skills. The experimental group, which used digital tools, showed a significant improvement in



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practical skills, with a mean score increase from 40.75 (pre-test) to 72.40 (post-test), resulting in a mean difference of 31.65 (SD = 7.12). This difference was statistically significant ($t = 14.45, p < 0.001$), indicating that the use of digital tools had a substantial positive effect on skill development. In comparison, the control group, which received traditional instruction, showed a smaller improvement in practical skills, with a mean increase from 40.50 (pre-test) to 50.60 (post-test), resulting in a mean difference of 10.10 (SD = 5.68). This difference was statistically significant ($t = 4.28, p < 0.01$), but the effect was considerably less pronounced than in the experimental group. These results suggest that digital learning tools significantly enhanced students' practical agricultural skills compared to traditional teaching methods.

Research Question Four:

How does the retention of agricultural knowledge differ between students taught using digital learning tools and those taught using traditional methods?

Table 4: Retention of Agricultural Knowledge Between Digital Tools and Traditional Methods

Group	Post-Test Mean	Retention Test Mean	Mean Difference	Standard Deviation	t-value	p-value
Experimental Group (Digital Tools)	75.80	74.10	1.70	4.32	1.45	0.15
Control Group (Traditional Methods)	52.90	47.60	5.30	3.98	4.22	<0.001

Note: Scores were based on a 100-point scale.

Table 4 presents the retention of agricultural knowledge between students taught using digital learning tools and those taught using traditional methods. The experimental group, which received instruction through digital tools, showed a slight decrease in mean scores from 75.80 (post-test) to 74.10 (retention test), with a mean difference of 1.70 (SD = 4.32). This difference was not statistically significant ($t = 1.45, p = 0.15$), indicating that students in the experimental group retained their knowledge relatively well. On the other hand, the control group, which was taught using traditional methods, experienced a more substantial decline in retention, with a mean score decrease from 52.90 (post-test) to 47.60 (retention test), resulting in a mean difference of 5.30 (SD = 3.98). This difference was statistically significant ($t = 4.22, p < 0.001$), suggesting that students in the control group had poorer retention of agricultural knowledge compared to those in the experimental group. These results indicate that digital learning tools contribute to better retention of agricultural knowledge over time compared to traditional teaching methods.

Research Question Five:

What challenges are encountered in the implementation of digital learning tools in agricultural education in rural schools?

Table 5: Challenges in the Implementation of Digital Learning Tools in Agricultural Education

Challenge	Frequency	Percentage (%)
Lack of electricity	85	85.0
Poor internet connectivity	80	80.0
Inadequate teacher training	70	70.0
Limited access to digital devices	65	65.0
Resistance to change from teachers	45	45.0
Insufficient technical support	40	40.0

Note: Frequency represents the number of respondents who reported each challenge.



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Table 5 presents the challenges encountered in the implementation of digital learning tools in agricultural education in rural schools. The most frequently reported challenge was the lack of electricity, with 85% of respondents identifying this as a major barrier to effective use of digital tools. Poor internet connectivity followed closely, with 80% of respondents highlighting this issue as a significant hindrance. Inadequate teacher training was also a prominent challenge, cited by 70% of respondents, indicating that many teachers lacked the necessary skills to effectively integrate digital tools into their teaching practices. Other challenges included limited access to digital devices (65%), resistance to change from teachers (45%), and insufficient technical support (40%). These findings underscore the infrastructural and training-related barriers that must be addressed to successfully implement digital learning tools in rural agricultural education settings.

Discussion of Findings

The findings of this study provide valuable insights into the effectiveness of digital learning tools in enhancing agricultural knowledge acquisition and skill development among secondary school students in rural Northern Nigeria. The results indicate that the baseline agricultural knowledge and skill levels of students were moderate to low, which aligns with previous studies that have highlighted the challenges faced by rural students in accessing quality education, particularly in specialized fields like agriculture (Adewale & Ibrahim, 2021). The moderate baseline knowledge and low skill levels suggest that traditional teaching methods have been insufficient in bridging the educational gap in rural areas. This finding is consistent with the broader literature on agricultural education in rural Sub-Saharan Africa, where students often lack access to updated learning resources and practical training opportunities (Olayemi & Adebayo, 2021). The introduction of digital learning tools, therefore, holds the potential to address these gaps by providing more engaging, interactive, and accessible learning experiences.

The significant improvement in agricultural knowledge acquisition observed in the experimental group, which used digital learning tools, further supports the growing body of evidence on the effectiveness of digital tools in education. This result is in line with studies by Nwosu et al. (2022) and Patel et al. (2022), who found that digital tools, such as mobile apps and virtual simulations, significantly enhance students' understanding of complex subjects, including agriculture. The experimental group's knowledge increase of 30.60 points, compared to the control group's 8.05 points, highlights the superior impact of digital tools over traditional methods. This finding also emphasizes the relevance of the Technology Acceptance Model (TAM), which suggests that students' perceived usefulness and ease of use of digital tools directly influence their learning outcomes (Davis, 1989). The significant improvement in knowledge acquisition suggests that when digital tools are integrated effectively into the curriculum, they can facilitate better understanding of agricultural concepts, which is crucial for the development of a skilled agricultural workforce.

In terms of practical skill development, the study found that students in the experimental group demonstrated a remarkable improvement, with a mean increase of 31.65 points in their practical skills. This result mirrors findings from other studies, such as those by Olayemi and Adebayo (2021), which showed that virtual reality (VR) and mobile apps enhance practical learning by allowing students to engage with real-world scenarios in a controlled environment. The hands-on experience provided by digital tools enables students to apply theoretical knowledge to practical situations, which is essential in agricultural education. In contrast, the control group's smaller improvement of 10.10 points suggests that traditional methods may not offer the same level of interactive and experiential learning opportunities. The results underscore the potential of digital tools to bridge the



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gap between theoretical knowledge and practical skill development, which is critical for students in rural areas who may not have easy access to physical agricultural training resources.

The retention of agricultural knowledge was another key area of interest in this study. The findings indicate that students in the experimental group retained their knowledge better than those in the control group. The slight decline in knowledge retention in the experimental group (1.70 points) compared to the larger decline in the control group (5.30 points) supports the idea that digital learning tools contribute to better long-term retention. This result aligns with the Constructivist Learning Theory, which emphasizes the importance of interactive, learner-centered approaches in promoting deep learning and retention (Piaget, 1970; Vygotsky, 1978). The ability of digital tools to provide continuous access to learning materials and foster active engagement may explain why students in the experimental group were able to retain more of what they had learned. The findings suggest that digital tools not only enhance immediate learning outcomes but also contribute to sustained knowledge retention, which is essential for the long-term development of agricultural skills.

Despite the positive outcomes, the study also identified several challenges in implementing digital learning tools in rural schools. The most significant challenges included a lack of electricity, poor internet connectivity, inadequate teacher training, and limited access to digital devices. These challenges are consistent with those reported in other studies on digital education in rural areas (Adewale & Ibrahim, 2021; Nwosu et al., 2022). The lack of electricity and internet connectivity are particularly problematic in rural Northern Nigeria, where infrastructure is often underdeveloped. Furthermore, the insufficient technical support and resistance to change from teachers highlight the need for comprehensive training programs and ongoing support to ensure the successful integration of digital tools into the classroom. These challenges must be addressed if digital learning tools are to be effectively utilized in agricultural education. The findings suggest that policymakers and educators must prioritize investments in infrastructure, teacher training, and digital resources to overcome these barriers and fully realize the potential of technology in agricultural education.

Conclusion

The results of this study demonstrate the significant potential of digital learning tools to improve agricultural knowledge acquisition, practical skill development, and knowledge retention among secondary school students in rural Northern Nigeria. The findings underscore the importance of integrating technology into agricultural education to bridge the gap between traditional teaching methods and the demands of modern agricultural practices. However, the challenges identified in the study highlight the need for targeted interventions to address infrastructural and training-related barriers. Future research should explore the development of context-specific digital tools and strategies to enhance the effectiveness of agricultural education in rural areas, particularly in regions with limited access to resources.

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Acoustic Analysis of Nigerian English Vowels: A Comparative Phonetic Study of Educated and Non-Educated Speakers

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Abstract

Nigerian English (NE) displays notable phonetic diversity, particularly in its vowel systems, shaped by the interplay of indigenous languages, social factors, and formal education. While prior research has extensively examined major NE varieties such as Yoruba, Hausa, and Igbo English, less attention has been given to minority sub-varieties, including Tiv and Urhobo English. This study presents a comprehensive acoustic investigation of vowel production in educated and non-educated speakers of these underexplored varieties, aiming to understand how formal education and social exposure influence vowel realization. A total of forty native NE speakers participated, evenly split between educated individuals (holding at least a bachelor's degree) and non-educated individuals (with primary or secondary education). Speech samples were collected through word lists and controlled sentences in quiet settings and analyzed using Praat software to measure vowel formants (F1, F2, F3), duration, and spectral features. Findings reveal systematic differences: educated speakers produced vowels closely aligned with Standard British English norms, whereas non-educated speakers exhibited vowel centralization, reduction, diphthong simplification, and substitutions influenced by their first languages. Specifically, monophthongs such as /i:/ and /ɔ:/ were altered in non-educated speech, while diphthongs like /eɪ/ and /aɪ/ often became monophthong zed. Vowel duration was generally longer in educated speakers, contributing to perceptible differences in intelligibility and prosody. These results suggest the emergence of a socially stratified NE vowel system and underscore the significant role of education and social experience in shaping vowel production. The study expands our understanding of NE phonology and highlights the need to include speakers from diverse educational and regional backgrounds in future phonetic and sociolinguistic research.

Keywords: Nigerian English, vowel acoustics, educated, non-educated speakers,

Introduction

Nigerian English (NigE) has long been a central focus of phonological research, particularly regarding its vowel systems. Early foundational studies, such as Dunstan (1969), examined the phonologies of twelve Nigerian languages in comparison with English, identifying specific areas that posed challenges for English language instruction in Nigeria. Building on this foundation, later research by Jibril (1982, 1986) and Jowitt (1991) categorized NigE into Northern and Southern varieties, highlighting the prominence of Hausa, Igbo, and Yoruba English. However, these influential studies often overlooked the phonological diversity present among smaller ethnic groups. More recent research has begun to address this gap by examining underrepresented varieties, including Urhobo and Tiv English (Amoniyan, 2023; Aor, 2021), thereby broadening the understanding of NigE phonology.



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Prior studies suggest that vowel patterns in NigE are largely predictable and strongly influenced by speakers' native phonologies (Simo Bobda, 2007; Jibril, 1982; Jowitt, 1991; Udofot, 1997). While this characterization generally applies to major varieties, it oversimplifies the more nuanced variations found in minority sub-varieties. The present study seeks to provide a detailed acoustic analysis of vowel systems in Urhobo and Tiv English, comparing the speech of educated and non-educated speakers to examine the influence of formal education and English exposure on vowel production.

Vowel Patterns in Nigerian English

The acoustic properties of vowels, including duration, formant frequencies, and spectral characteristics, are essential for understanding phonetic variation in NigE. Research indicates that vowel realization often diverges from Standard British English (SBE) due to the influence of indigenous phonological structures (Adegbembo et al., 2021; Melefa & Amoniyan, 2020; Mustapha, 2004). For instance, in Yoruba English, the schwa /ə/ in unstressed syllables is frequently replaced by stronger vowels such as /a/ or /ɑ:/, resulting in alterations to stress patterns and vowel quality. Additionally, vowel insertion to resolve syllabic consonants, a feature transferred from native consonant-vowel structures, affects both vowel duration and quality, particularly among non-educated speakers. Despite extensive research on major NigE varieties, systematic acoustic comparisons between educated and non-educated speakers remain limited. Most studies have relied on word lists or reading passages, often neglecting spontaneous speech. Consequently, careful comparisons of vowel formants (F1, F2, and F3), duration, and spectral characteristics across educational and social groups are necessary to understand how education and English exposure shape vowel production in Nigerian English.

Tiv and Urhobo English as Understudied Varieties

Similar to the under-researched Tiv English (Aor, 2021; Mbapuun, 2021), Urhobo English represents a sub-variety of NigE spoken by minority ethnic groups whose vowel systems may differ significantly from the major varieties. Investigating these sub-varieties is essential for developing a comprehensive understanding of NigE's phonetic landscape. Comparing vowel production between educated and non-educated speakers in these groups can illuminate the extent to which native phonology, second-language acquisition, and formal education collectively influence vowel realization in Nigerian English.

Literature Review

Phonological Studies of Nigerian English

Extensive research has explored the phonology of Nigerian English (NigE), examining both segmental and suprasegmental features. Scholars have investigated vowel shifts, stress patterns, and rhythm, consistently highlighting the influence of indigenous languages on English pronunciation. For instance, Melefa and Amoniyan (2020) analyzed stress patterns in Tiv English, identifying unique stress behaviors shaped by native phonologies. Similarly, Amoniyan (2023) studied stress assignment among Tiv English speakers, demonstrating how first-language acquisition impacts second-language learning and English prosody. Recent investigations have also focused on the vowel systems of specific Nigerian languages. Aziza (2025) conducted a detailed phonemic analysis of Tiv vowels, distinguishing /v/, /ɔ/, /o:/, and /ɔ:/ as distinct phonemes. Likewise, Aor (2021) examined phonemic substitutions in the English-Tiv loan phonology, analyzing how vowel and consonant substitutions influence Tiv grammar and highlight patterns of L1 transfer into English. These studies underscore the complexity and variability of vowel systems in Nigerian English, particularly in under-researched sub-varieties.



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Acoustic Analyses of Vowel Systems

Acoustic studies have provided critical insights into the vowel systems of Nigerian languages. A comparative acoustic study of Gokana and Urhobo vowel systems by Amoniyan (2024) examined their phonetic, phonological, and acoustic properties, revealing both distinctions and similarities in vowel realization. Similarly, Ekiugbo (2019) presented a descriptive phonological analysis of Uvwie, exploring its phonemic inventory and the organization of its vowel system. These investigations highlight the essential role of acoustic analysis in capturing the fine-grained characteristics of Nigerian English vowels and point to the need for further studies in this area, especially for minority sub-varieties.

Objectives of the Study

This study seeks to:

1. Identify and characterize unique vowel patterns in the evolving Urhobo English sub-variety, highlighting their relevance to the ongoing standardization of Nigerian English.
2. Expand the database of Nigerian English vowel phonology beyond the dominant Hausa, Igbo, and Yoruba English varieties.
3. Compare vowel formants (F1, F2, F3), duration, and spectral properties between educated and non-educated speakers to understand the influence of education and exposure to English on vowel production.

Social Influence on Nigerian English Vowels

Research indicates that mother-tongue interference plays a significant role in shaping vowel realization in Nigerian English (NE). For example, Yoruba speakers often replace the Received Pronunciation (RP) vowel /ɪ/ with [i], while Hausa speakers may centralize /ʊ/ toward [u] (Adegbembo et al., 2021; Usar & Ofoegbu, 2017). These patterns are especially pronounced among non-educated speakers, who rely heavily on native phonological structures and have limited exposure to formal English instruction. In contrast, educated speakers produce vowel qualities that more closely approximate Standard British English (SBE), reflecting the influence of formal education and extensive exposure to English (Aor, 2021; Melefa & Amoniyan, 2020). These findings suggest that social and educational factors interact to create a socially stratified phonetic landscape within Nigerian English, emphasizing the need to consider both linguistic background and educational context when analyzing vowel production.

Methodology

The study involved forty native Nigerian English (NE) speakers, divided evenly into two groups based on educational background: Educated speakers (n = 20): are Participants having at least a bachelor's degree, demonstrated fluency in NE, and had consistent exposure to formal English instruction and non-educated speakers (n = 20): are Participants had completed only primary or secondary education and had limited exposure to formal English. All participants reported at least one Nigerian first language (L1), and individuals with extended residence outside Nigeria (more than two years) were excluded to control for foreign language influence. Participants' ages ranged from 20 to 55 years, with balanced representation of males and females across both groups, ensuring demographic diversity. Two types of speech materials were employed to elicit vowel production: Word list: A set of 50 target words representing all major NE vowel phonemes in controlled phonetic contexts. This allowed for systematic measurement of vowel properties under consistent conditions. Sentences: Carefully constructed sentences were used to elicit connected speech and natural prosody, minimizing reading-induced hyper articulation and providing a more accurate representation of spontaneous vowel production.



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Acoustic Analysis

Speech data were recorded using high-quality digital recorders in quiet environments or sound-treated rooms to ensure optimal clarity. Acoustic analysis was conducted using **Praat software** (Boersma & Weenink, 2024), which enabled precise extraction of vowel formants (F1, F2, F3) and measurement of vowel duration. **Formant measurement:** The midpoint of monophthongs was measured, while diphthongs were analyzed at multiple trajectory points to capture their dynamic spectral characteristics and **Duration measurement:** Vowel duration was determined from onset to offset using combined spectrographic and waveform cues, ensuring accurate temporal analysis. This methodology ensured rigorous, systematic, and reliable acoustic analysis of vowel production across both educated and non-educated NE speakers.

Presentation of Results

Monophthong Variation

The acoustic analysis revealed systematic differences between educated and non-educated Nigerian English (NE) speakers in the production of monophthong vowels. Educated speakers generally produced vowels closer to Standard British English (SBE) norms, whereas non-educated speakers exhibited systematic shifts influenced by their native languages.

Table 4.1

Vowel	SBE	Educated NE	Non-Educated NE	Observation
/i:/	[i:]	[i]	[ɪ]	Non-educated speakers show slight centralization.
/ɛ/	[ɛ]	[ɛ]	[e]	Raising observed in non-educated NE.
/ɔ:/	[ɔ:]	[ɔ]	[a]	Shortening and lowering in non-educated NE.

Educated speakers-maintained vowel qualities that approximated SBE norms, whereas non-educated speakers demonstrated consistent centralization and lowering or raising of vowels. This suggests a strong influence of first-language phonology on NE vowel production among non-educated speakers (Adegbenbo et al., 2021; Mustapha, 2004).

Diphthong Simplification

Diphthongs were particularly susceptible to simplification in non-educated speakers, often resulting in monophthongization and altered vowel quality.

Table 4.2

Diphthong	SBE	Educated NE	Non-Educated NE	Note
/eɪ/	[eɪ]	[e]	[ɛ]	Monophthongization prevalent in non-educated speakers.
/əʊ/	[əʊ]	[o]	[ɔ]	Shortened and rounded differently.
/aɪ/	[aɪ]	[ai]	[a]	Reduced in non-educated speakers; more native-like in educated speakers.

These results indicate that non-educated speakers simplify diphthongs more frequently, likely due to the influence of native consonant-vowel structures and limited exposure to formal English pronunciation. Educated speakers, on the other hand, retained more dynamic vowel glides, reflecting greater approximation to SBE norms.

Vowel Duration

Vowel duration also differed notably between groups:



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- i. Educated speakers: Demonstrated longer vowel durations in stressed syllables, closely mirroring SBE temporal patterns.
- ii. Non-educated speakers: Produced shorter vowels across both stressed and unstressed syllables, contributing to perceptible differences in intelligibility and naturalness.

Shortened vowel duration in non-educated speakers is consistent with reduced exposure to formal English instruction and the influence of L1 timing patterns. This temporal compression also affects the rhythm and prosody of connected speech, making non-educated NE appear faster and more compact.

Summary of Findings

Overall, the results show that educational background and exposure to English significantly affect vowel production in NE. Educated speakers exhibit vowel qualities and durations that closely align with SBE norms, while non-educated speakers show centralization, diphthong simplification, and shortened vowel duration. These patterns suggest the emergence of a socially stratified NE vowel system, where social and educational factors shape phonetic variation.

Discussion of Findings

The findings of this study provide compelling acoustic evidence that the vowel system of Nigerian English (NE) is not uniform across social or educational groups. Contrary to earlier claims suggesting that NE vowel patterns are largely predictable (Simo Bobda, 2007), our results indicate that non-educated speakers exhibit systematic deviations from standard patterns. These deviations highlight the limitations of overgeneralizing NE vowel behavior, as prior studies primarily focused on educated speakers or major varieties such as Yoruba, Hausa, and Igbo English.

Social and Educational Influences on Vowel Production

Education and exposure to formal English instruction emerged as key factors influencing vowel realization. Educated speakers produced vowels that closely approximated Standard British English (SBE) norms in both quality and duration. In contrast, non-educated speakers demonstrated a marked influence of their first-language (L1) phonology. For example, monophthongs were often centralized or raised, diphthongs underwent simplification or monophthongization, and vowel duration was generally shorter. These patterns indicate that formal education and extensive exposure to English play a critical role in shaping phonetic competence, allowing educated speakers to produce vowels that are more intelligible and prosodically aligned with global English standards (Aor, 2021; Adegbenbo et al., 2021).

Emergence of Socially Stratified Vowel Patterns

The systematic vowel variations observed among non-educated speakers suggest the evolution of a socially stratified NE vowel system. Centralization, vowel shortening, and diphthong reduction collectively form distinctive phonetic markers that differentiate speakers based on educational background and social exposure. This stratification has implications not only for intelligibility but also for sociolinguistic identity, as vowel production becomes a subtle indicator of social and educational status.

Implications for Nigerian English Phonology

These findings underscore the necessity of including speakers from diverse educational and regional backgrounds in phonetic and sociolinguistic studies of NE. Focusing exclusively on educated speakers or major ethnic varieties risks producing incomplete and potentially biased representations of NE vowel systems. Future research should therefore expand to include minority sub-varieties such as Tiv and Urhobo English, as well as speakers with varied educational experiences, to achieve a more comprehensive understanding of the language's phonetic landscape.



Conclusion

This study provides robust acoustic evidence demonstrating that Nigerian English (NE) vowels exhibit significant variation between educated and non-educated speakers. Educated speakers produced vowel qualities and durations that closely approximate Standard British English (SBE) norms, reflecting the influence of formal education and extensive exposure to English. In contrast, non-educated speakers consistently exhibited vowel reduction, centralization, and diphthong simplification, indicating the strong impact of first-language phonology and limited formal instruction. These findings challenge the longstanding assumption of uniformity in NE vowel phonology and highlight the critical role of social and educational factors in shaping speech patterns. The emergence of systematic differences suggests that NE vowel systems are socially stratified, with educational background serving as a key determinant of phonetic variation. The study also underscores the importance of including speakers from minority and underrepresented regional varieties, such as Tiv and Urhobo English, in future research. Expanding the scope of phonetic studies to encompass diverse ethnic, social, and educational backgrounds will provide a more accurate and comprehensive understanding of NE vowel variation. Overall, the research contributes to the growing body of knowledge on Nigerian English phonology, emphasizing the interplay between language, social factors, and education. It also has practical implications for English language teaching in Nigeria, particularly in designing curricula and pronunciation training that account for the phonetic realities of learners from varied linguistic and educational backgrounds.

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