

**JOURNAL OF SCIENCE,
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[JOSEH]**

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Journal of Science, Education and Humanities (JOSEH) is an official publication of Akwa Ibom State College of Education, Afaha Nsit, Nigeria. As a multidisciplinary journal, it is devoted to explaining, sharing research ideas, findings and innovations as well as providing information and understanding on issues bordering on Science, education and humanities.

The Journal contains articles that dwell on socioeconomic development, Science education-related studies, entrepreneurship, vocational education, Counseling and curriculum studies, reading, Ibibio personal names and Caribbean literature studies and information communication technology.

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Papers for publication in the journal should not have been published previously in another journal, in any other language or be under consideration for publication elsewhere. The articles must be typed (word processing only) double-spaced on A4 – Size paper on one side of the paper only and not more than 21 pages including references. Ample margins should be left at the top (2.5 cm), bottom (1.5 cm), left (2.5 cm) and right (2 cm) in two hard copies for use by reviewers. Scientific names must be italicized and authority given at first mention. All pages of manuscripts except the title page must be numbered where an article is found publishable, authors are requested to submit two hard copies of final corrected version together with a soft copy in a re-writeable CD-Rom containing the article. However, online submission can be done using JOSEH Website: www.akscoejoseh.org, Email: info@akscoejoseh.org

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Journal of Science, Education and Humanities (JOSEH) is an official publication of Akwa Ibom State College of Education, Afaha Nsit, Nigeria. It is a multidisciplinary journal that takes articles from different areas of study, particularly science, education and humanities. This volume contains twenty one articles that dwell on socio-economic development, science education studies, entrepreneurship/vocational education, counseling and curriculum studies, reading, Ibibio, personal names and study on Caribbean literature, Information Communication Technology (ICT). It is our pleasure to present this volume of the journal to the reading public and we hope it will be a very valuable resource to you.

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Prof. Daniel George Udo
Editor-in-Chief

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LIST OF CONTRIBUTORS

Osu, S. R.

Department of Biology, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria.

Nwaogu, A. G.

Department of Plant Health Management, College of Crop and Soil Science, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

Onwineng, V. E.

Department of Biology, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria.

AndrewEssien, M. U.

Department of Biology, Akwa Ibom State, College of Science & Technology, Nung Ukim Ikono, Nigeria

Akpan, I. E.

Department of Political Science, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Felix, U. O.

Department of Economics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Paul, K. U.

Department of Political Science, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Akpan, I. A.

Department of Chemistry, Akwa Ibom State, College of Science & Technology, Nung Ukim Ikono, Nigeria

Umoh, E. O.

Department of Agricultural Engineering, Akwa Ibom State University, Ikot Akpaden, Nigeria

Andrew, U. E.

Department of Chemistry, Akwa Ibom State, College of Science & Technology, Nung Ukim Ikono, Nigeria

Atai, E. S.

Department of Physics, Akwa Ibom State College of Science & Technology, Nung Ukim Ikono, Nigeria

Idungafa, M. A.

Department of Agriculture, Akwa Ibom State College of Science & Technology, Nung Ukim Ikono, Nigeria.

Udo, S. S.

Department of Economics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Udo, E. G.

Department of Economics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Allam, J. N.

Department of French, Federal College of Education Zaria, Kaduna State, Nigeria

Udo, I. J.

Department of French, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Ben, M. G.

Department of Biology, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Ekong, U. J.

Department of Biology, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Esuong, U. U.

Department of Mathematics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Ibok, E. O.

Department of Mathematics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Udo, O. F.

Department of Mathematics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Ettah, B. E.

Department of Economics, Faculty of Social Sciences University of Uyo, Uyo, Nigeria

Akpan, O. M.

Department of Economics, School of Arts and Social Sciences, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Udo, E. G.

Department of Economics, School of Arts and Social Sciences, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Eyenaka, F. D.

Department of Physics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

John, D. E.

Department of Physics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Dan, N. E.

Department of Physics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Akpan, G. E.

Professor of Economics, University of Uyo, Uyo

Akpan, U. R.

Department of Economics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Iwok, U. A.

Department of Economics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Archibong, A. U.

Department of Integrated Science, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria.

Osu, S. R.

Department of Biology, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria.

Udoidiok, D. E.

Department of Biology, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria.

Efiong, F.A.

Department of Mathematics, University of Uyo, Uyo, Akwa Ibom State, Nigeria

Enyiduru, E. H.

Department of Mathematics, Michael Okpara University of Agriculture Umudike

Effiong, L. E.

Department of Mathematics, Abia State Polytechnic, Aba, Abia State, Nigeria.

Michael, N, J.

Department of Mathematics, Akwa Ibom State University, Ikot Akpaden, Nigeria.

Sampson, M.I.

Department of Mathematics, Akwa Ibom State University, Ikot Akpaden, Nigeria.

LIST OF CONTRIBUTORS VOL 7 (2)

Osu, S. R.

Department of Biology, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria.

Bassey, I. N.

Department of Botany and Ecological Studies, University of Uyo, Uyo, Nigeria

Nwaogu, A. G.

Department of Plant Health Management, College of Crop and Soil Science, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Tel: +2347032196112

Onwineng, V. E.

Department of Biology, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria.

Akpan, G. F.

Department of English, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria.

James, U. S.

Department of Science Education, University of Uyo, Uyo

Omachoko, Noah

Department of Science Education, University of Uyo, Uyo

James-inyang, G. L.

Department of Biology, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Afang, A. N.

Department of Biology, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Alphonsus, E. N.

Department of Biology, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Udoh, J. D.

Department of Business Education, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Ndeh, E. S.

Department of Chemistry, Federal College of Education (Technical) Bichi, Kano State, Nigeria.

Uyai, A. U

Department of Integrated Science, Federal College of Education (Technical) Bichi, Kano State, Nigeria.

Etor, A. C.

Department of Social Studies, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Akpan, U. S.

Department of Social Studies, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Asuquo, G. O.

Department of Social Studies, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Nseabasi, A. S.

Department of Educational Foundations, School of Education, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

James, S. F.

Department of Educational Foundations, School of Education, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Abraham, F. A.

Department of Educational Foundations, School of Education, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

Thompson, E. N.

Department of Political Science, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria.

Esetang, Aniefiok

Ex. Director- National Orientation Agency(NOA), Akwa Ibom State

Wilson, A. B.

Department of Political Science, College of Education, Afaha Nsit, P.M.B. 1019 Etinan,
Akwa Ibom State, Nigeria.

Udoh, O. E.

Department of Physical and Health Education, College of Education, Afaha Nsit, P.M.B.
1019 Etinan, Akwa Ibom State, Nigeria

Edidem, E. U.

Department of Physical and Health Education, College of Education, Afaha Nsit, P.M.B.
1019 Etinan, Akwa Ibom State, Nigeria

Udofia, E. A.

Department of Physical and Health Education, College of Education, Afaha Nsit, P.M.B.
1019 Etinan, Akwa Ibom State, Nigeria

Uwah, V. A.

Department of Computer Science, College of Education, Afaha Nsit, P.M.B. 1019 Etinan,
Akwa Ibom State, Nigeria

Ekang, A. E.

Department of Political Science, College of Education, Afaha Nsit, P.M.B. 1019 Etinan,
Akwa Ibom State, Nigeria

Emilia, E. E.

Girls' High School, Ikot Ibiok, Eket, Akwa Ibom State

Uyouko, A. U.

Department of Computer Science, College of Education, Afaha Nsit, P.M.B. 1019 Etinan,
Akwa Ibom State, Nigeria

Esu, U. S.

Department of Early Childhood Care & Education, College of Education, Afaha Nsit, P.M.B.
1019 Etinan, Akwa Ibom State, Nigeria



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Effect of Organic Supplement and Cassava Variety on the Growth of Cassava Grown on Crude Oil Impacted Soil in Niger Delta Region, Nigeria

^{*1}Osu, S. R., ²Nwaogu, A. G., ³Onwineng, V. E. & ⁴AndrewEssien, M. U.

^{*1&3}Department of Biology, College of Education Afaha Nsit,
P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

²Department of Plant Health Management, College of Crop and Soil Science, Michael Okpara
University of Agriculture, Umudike, Abia State, Nigeria.

⁴Department of Biology, Akwa Ibom State, College of Science & Technology, Nung Ukim
Ikono, Nigeria.

^{*}Corresponding Author E-mail: samuelrobert2007@yahoo.com. Tel: +2348028260825

Abstract

This study evaluated the effects of organic supplements (poultry manure, compost, and green manure) and cassava varieties (TMS 30572, TME 419, and NR 8082) on the growth performance of cassava cultivated in crude oil-impacted soils. A field experiment was conducted using a randomized complete block design with three replications. Results showed significant differences in growth parameters among treatments. Poultry manure application led to the highest plant height (88 cm for TMS 30572), number of leaves (35 for TMS 30572), and tuber yield (4.00 kg/plant for TMS 30572). The lowest values were observed in compost-treated TMS 30572 (74 cm height, 22 leaves, and 2.90 kg/plant yield). Cow dung and green manure also improved cassava growth, with NR 8082 achieving 90 cm in height and 3.80 kg/plant yield under poultry manure. Across all treatments, NR 8082 exhibited resilience but recorded lower growth metrics compared to TMS 30572. Initial soil analysis revealed high sand content (870 g/kg), slightly acidic pH (6.1), and moderate organic carbon (12.37 g/kg), but total petroleum hydrocarbon (155.72 mg/kg) indicated contamination. The findings highlighted the importance of organic amendments in enhancing cassava growth in contaminated soils, with poultry manure being the most effective. Based on the results, it was recommended that farmers adopt organic farming practices, particularly poultry manure application, to rehabilitate oil-impacted soils and cultivate resilient cassava varieties like TMS 30572. Further research should examine the long-term impact of organic amendments on soil fertility and cassava productivity in crude oil-affected regions.

Keywords: Organic supplements, Cassava varieties, Crude oil contamination, Soil fertility, Crop yield

1.0. INTRODUCTION

Crude oil pollution has become a pervasive environmental issue, particularly in regions rich in petroleum resources such as the Niger Delta in Nigeria. The frequent occurrences of oil spills and leakage from pipelines have led to severe soil degradation, adversely affecting agricultural productivity and compromising food security (Nwankwo et al., 2019). Soil contamination from crude oil disrupts essential soil properties, such as structure, porosity, and nutrient availability, rendering it inhospitable for crop growth (Obi et al., 2019; Osu et al., 2020). Among the crops severely impacted by oil pollution is cassava

(*Manihot esculenta*), a crucial staple food that serves as a primary source of carbohydrates for millions of people, particularly in sub-Saharan Africa (Akinola & Ogunleye, 2020).

Cassava is known for its resilience and adaptability to various environmental conditions; however, its growth is significantly hampered in crude oil-contaminated soils. The presence of toxic hydrocarbons and heavy metals in polluted soils can lead to reduced growth rates, lower tuber yield, and poor quality of harvested produce (Nwachukwu et al., 2021). Thus, addressing the challenges posed by crude oil contamination is essential to ensure the sustainable production of cassava and, consequently, food security in affected regions (Ekanem et al., 2018).

To mitigate the negative effects of soil contamination, organic supplements have emerged as a viable solution for enhancing soil health and promoting plant growth. Organic amendments, such as compost, manure, and biochar, have been shown to improve soil fertility, restore microbial activity, and enhance the physical properties of soils (Mala et al., 2021). These amendments can effectively reduce soil toxicity levels, improve nutrient availability, and promote better water retention, thereby supporting the growth of crops in polluted environments (Audu et al., 2022). However, the effectiveness of organic supplements may vary depending on their type and application method, as well as the specific crop variety being cultivated.

The selection of appropriate cassava varieties that demonstrate resilience to adverse conditions is equally critical. Different cassava varieties exhibit varying degrees of tolerance to environmental stressors, including soil contamination. Identifying and cultivating these resilient varieties can play a significant role in enhancing cassava productivity in degraded soils (Ogundipe et al., 2020). By combining the use of organic supplements with the selection of suitable cassava varieties, it may be possible to achieve improved growth and yield of cassava in crude oil-impacted soils, thereby supporting sustainable agricultural practices.

The growth and productivity of cassava (*Manihot esculenta*) are significantly affected by soil health and environmental conditions. In regions where crude oil extraction is prevalent, the soil often becomes contaminated, leading to detrimental effects on agricultural productivity (Odu et al., 2018). This literature review explores the impact of organic supplements and cassava varieties on cassava growth in crude oil-impacted soils, highlighting relevant studies and findings (Osu et al., 2021).

Crude oil contamination alters the physicochemical properties of soil, reducing its fertility and microbial activity (Fashae et al., 2020). Research indicates that hydrocarbons can lower soil pH, organic matter content, and essential nutrients like nitrogen, phosphorus, and potassium, which are crucial for plant growth (Odu et al., 2018). A study by Ogunyemi et al. (2019) reported that crude oil contamination resulted in significant declines in soil moisture and nutrient levels, adversely affecting the growth parameters of crops, including cassava.

Organic amendments, such as compost, poultry manure, and green manure, have been widely researched for their potential to improve soil fertility and restore productivity in contaminated soils. Organic compost, which is rich in nutrients and beneficial microorganisms, has been shown to enhance soil structure and fertility (Abdulazeez et al., 2019). Poultry manure is another effective organic supplement that provides essential nutrients to plants. A study by Oyetunji et al. (2021) demonstrated that poultry manure improved the growth and yield of cassava in contaminated soils, leading to increased tuber weight and plant height compared to untreated controls. Green manure crops, particularly legumes, can fix atmospheric nitrogen and improve soil organic matter content when incorporated into the soil (Akintoye et al., 2020). Research by Oke et al. (2020) revealed that the use of green manure significantly

enhanced the growth of cassava by improving soil nutrient availability and reducing the negative effects of hydrocarbon contamination.

Different cassava varieties exhibit varying degrees of adaptability and resilience to adverse soil conditions, including contamination. For instance, the variety TME 419 is known for its high yield potential and resistance to diseases, making it a suitable choice for cultivation in suboptimal conditions (Nworgu *et al.*, 2019). Other varieties, such as NR 8082 and TMS 30572, are recognized for their drought tolerance and ability to thrive in nutrient-poor soils (Ofoegbu *et al.*, 2018). Studies have shown that selecting the right cassava variety can mitigate the impacts of soil contamination. According to Afolabi *et al.* (2021), cassava varieties that demonstrate tolerance to abiotic stress can maintain growth and yield in crude oil-impacted soils, suggesting that genetic diversity plays a crucial role in cassava cultivation under adverse conditions.

The integration of organic supplements with resilient cassava varieties presents a sustainable approach to restoring soil health and enhancing cassava productivity in crude oil-impacted areas. This integrated approach not only improves soil nutrient status but also promotes biodiversity and microbial activity, which are vital for healthy soil ecosystems (Adediran *et al.*, 2019).

Research by Ogundipe *et al.* (2021) highlighted that combining organic amendments with tolerant cassava varieties significantly improved growth parameters and tuber yield in contaminated soils compared to single treatments. This finding underscores the importance of adopting sustainable agricultural practices to address the challenges posed by soil contamination.

This study aims to investigate the effects of organic supplements and cassava variety on the growth of cassava grown in crude oil-impacted soils. By examining the interactions between organic amendments and different cassava varieties, this research seeks to identify effective strategies for mitigating the adverse effects of crude oil pollution on cassava production. The findings will provide valuable insights into sustainable agricultural practices that can enhance food security and livelihoods in oil-affected regions.

1.1. Aims and Objectives of the Study

The aim of this study is to assess the effectiveness of organic supplement and cassava variety on the growth of cassava grown on crude oil impacted soil at Ikot Ada Udo in Ikot Abasi L.G.A. of Akwa Ibom State. Its specific Objectives include to:

- (i) Determine some soil properties of the Oil-Spillage Site used for the experiment
- (ii) Determine the Impact of Organic Supplement on Cassava Growth in Polluted Soils
- (iii) Examine the Response of Different Cassava Varieties to Crude Oil Contamination
- (iv) Evaluate the Interaction between Organic Supplements and Cassava Varieties in Contaminated Soil
- (v) Quantify the Improvement in Soil Health due to Organic Supplement Application
- (vi) Assess the Overall Impact on Cassava Yield and Quality
- (vii) Recommend Best Practices for Cassava Cultivation in Crude Oil-Impacted Regions

These objectives cover the key factors in understanding how organic supplements and cassava variety selection can mitigate the effects of crude oil contamination on soil and crop health, ultimately aiming to support sustainable agricultural practices in polluted environments.

1.2. Statement of the problem

Crude oil contamination poses a serious threat to soil health and agricultural productivity in oil-rich regions, especially in the Niger Delta, where frequent oil spills and leaks have degraded vast areas of arable land. This pollution disrupts soil structure, reduces essential nutrients, and introduces toxic hydrocarbons and heavy metals that severely limit plant growth. For farmers in these areas, cassava—a staple crop that provides a crucial source of food and income—is particularly vulnerable to the adverse effects of oil pollution. Contaminated soils often lead to poor cassava yield, low-quality tubers, and reduced economic viability, threatening food security and livelihoods in affected communities.

Despite the growing awareness of these challenges, solutions for rehabilitating crude oil-polluted soils remain inadequate and costly. Traditional soil remediation techniques often rely on chemical methods, which are not only expensive but can also introduce further ecological disturbances. There is an urgent need for sustainable, affordable alternatives that can support soil recovery while enabling farmers to continue cultivating essential crops like cassava in polluted environments.

Organic supplements such as compost, manure, and biochar have shown promise in improving soil quality, enhancing nutrient availability, and reducing toxicity in contaminated soils. However, little is known about their specific effects on cassava growth in oil-polluted soils, particularly when combined with different cassava varieties that may exhibit varying levels of tolerance to harsh conditions. Identifying the most effective organic supplements and resilient cassava varieties could offer a sustainable solution for increasing cassava productivity in crude oil-impacted soils, contributing to both soil restoration and food security.

This study seeks to address these pressing issues by examining the effects of organic supplements and cassava variety selection on the growth and yield of cassava grown in crude oil-contaminated soils. By providing insights into effective soil management and crop selection strategies, this research aims to support sustainable agriculture in oil-polluted areas and promote the resilience of rural farming communities affected by environmental degradation.

1.3. Justification of the study

However, this research is crucial as it addresses the need for sustainable solutions to maintain and enhance cassava productivity in oil-polluted areas. By focusing on organic supplements and cassava variety selection, it holds promise for improving soil health, crop yield, and food security, thus contributing positively to both local communities and the broader agricultural sector. The justifications of this research include:

(i) Environmental and Agricultural Relevance of Crude Oil Pollution

- The Niger Delta and other oil-rich regions face severe crude oil pollution, negatively impacting soil health and the productivity of staple crops. This contamination leads to reduced soil fertility, altered soil structure, and the presence of toxic hydrocarbons, all of which threaten agricultural sustainability.
- Cassava (*Manihot esculenta*), a staple crop in Nigeria and many developing countries, is crucial for food security and income. However, crude oil-impacted soils challenge its growth and yield, making it vital to explore solutions that could help cassava thrive under these conditions.

(ii) Importance of Organic Supplements in Soil Remediation

- Organic supplements such as compost, manure, and biochar have shown potential in remediating polluted soils by improving soil structure, enhancing nutrient content, and promoting microbial activity. These supplements could mitigate the toxic effects of hydrocarbons in crude oil, making them an eco-friendly and cost-effective option for soil remediation.
- The study of organic supplements in cassava cultivation within contaminated soils could pave the way for sustainable remediation practices that rehabilitate the soil while supporting local agriculture.

(iii) Identification of Cassava Varieties with High Tolerance to Polluted Conditions

- Different cassava varieties have varying levels of tolerance to environmental stresses, including pollution. Identifying and utilizing varieties that perform better in crude oil-impacted soils can enhance crop resilience and ensure a more reliable yield.
- Research on cassava variety selection for polluted soils supports the goal of improving agricultural output in degraded environments, which is critical for communities in affected regions.

(iv) Contribution to Food Security and Livelihoods in Oil-Contaminated Areas

- For rural communities, cassava is not only a dietary staple but also a source of income. Crude oil contamination threatens food security and the livelihood of farmers who rely on crop productivity. By understanding how organic supplements and specific cassava varieties can counteract pollution effects, this research could contribute to stabilizing or increasing cassava yields despite soil degradation.
- Developing resilient cassava cultivation practices for contaminated soils directly benefits food security and local economies in oil-producing regions.

(v) Advancement of Sustainable Agricultural Practices

- The focus on organic supplementation aligns with sustainable agricultural practices, which emphasize minimal environmental impact and soil health restoration. This study could lead to evidence-based recommendations on sustainable farming techniques, promoting responsible use of organic materials for soil health improvement.
- By evaluating natural solutions to combat pollution, this research supports global goals for sustainable development, particularly in developing regions grappling with industrial pollution and environmental degradation.

(vi) Limited Existing Research on Cassava and Organic Amendments in Polluted Soils

- While cassava is widely studied for its resilience and adaptability, limited research exists on its growth performance in oil-contaminated soils, especially when combined with organic supplements. This study fills a gap in current agricultural and environmental research by focusing on practical, eco-friendly remediation approaches for an essential crop.
- The findings could offer valuable insights for agronomists, environmental scientists, and policymakers interested in addressing the challenges of agriculture in oil-polluted regions.

(vii) Policy Implications and Recommendations

- This research could inform policy decisions on land management and agricultural practices in oil-impacted areas. Insights gained from this study could guide policymakers in promoting organic

remediation methods and selecting crop varieties suited for challenging environments, ultimately supporting rural development initiatives.

2.0. MATERIALS AND METHODS

2.1. Site Description:

Ikot Ada Udo, a Village in Ikot Abasi Local Government of Niger Delta is one of the onshore onshore locations where hydrocarbon was discovered in commercial quantities more than 50 years ago in Nigeria, but has remained untapped. During the years these wells remained corked, oil and gas have spilled from the corked wells several times (Udo, 2008). A major spill event occurred between August and November, 2007 with extensive land area and aquatics system pollution. Following this large-scale spill, surveys were conducted in 2008 (Udo, 2008) and in 2012 (Udo and Chukwu, 2014) to assess the effects of the pollution on land/soil, plants and aquatic lives and other components of the impacted environment. A field experiment was conducted under natural climatic and environmental conditions in 2016 and repeated in 2017 planting seasons.



Fig 1: The location of the corked oil well at Ikot Ada Udo in Ikot Abasi L. G.A. of Akwa Ibom State, Nigeria

Source: (Udo, 2018)

2.2. Field Experimental Procedure

This section describes the step-by-step procedure for conducting the field experiment on the "Effect of Organic Supplement and Cassava Variety on the Growth of Cassava Grown on Crude Oil Impacted Soil." The experiment investigates three cassava varieties (TMS 30572, TME 419, and NR 8082) and three organic supplements (poultry manure, cow dung, and compost) to assess their combined impact on cassava growth in contaminated soils.

1. Site Selection and Preparation

- (i) The study area was conducted in a region known to have soils impacted by crude oil, ensuring the soil was representative of areas affected by oil pollution. Prior to planting, soil samples were taken from the top 0-20 cm layer to establish baseline contamination levels and soil fertility parameters (Adeoye *et al.*, 2021).
- (ii) The field was then cleared, plowed, and ridged to ensure adequate soil aeration and uniformity across plots. Each plot measured 4 m x 5 m with a 1 m gap between plots to avoid cross-contamination of treatments.

2. Experimental Design

- A Randomized Complete Block Design (RCBD) with three replications was used to minimize variability due to soil heterogeneity (Adediran *et al.*, 2020). The treatments included nine combinations of cassava variety and organic supplement application, along with a control plot without organic amendments for each variety.
- The nine treatments consisted of:
 - (i) TMS 30572 + Poultry Manure
 - (ii) TMS 30572 + Cow Dung
 - (iii) TMS 30572 + Compost
 - (iv) TME 419 + Poultry Manure
 - (v) TME 419 + Cow Dung
 - (vi) TME 419 + Compost
 - (vii) NR 8082 + Poultry Manure
 - (viii) NR 8082 + Cow Dung
 - (ix) NR 8082 + Compost

3. Organic Supplement Preparation and Application

- (i) The three organic supplements (poultry manure, cow dung, and compost) were air-dried and screened for contaminants before application. They were applied at a rate of 10 tons/ha as per standard recommendations for soil amendment in similar studies (Akinrinde *et al.*, 2019).
- (ii) Each organic supplement was uniformly mixed into the soil within each designated plot two weeks prior to planting to allow for microbial activity and initial decomposition. This step was essential to ensure that the nutrients from the organic materials were available during the early stages of cassava growth.

4. Planting of Cassava Varieties

- (i) Healthy, disease-free stem cuttings (25 cm in length) from the three cassava varieties (TMS 30572, TME 419, and NR 8082) were obtained from certified agricultural research institutes (Oyetunji *et al.*, 2020).
- (ii) Cuttings were planted at a spacing of 1 m x 1 m, following guidelines for cassava planting density, with 20 cuttings per plot. This spacing was chosen to ensure optimal growth and minimize competition among plants (Nworgu & Okeke, 2018).

5. Watering and Weed Management

- (i) To simulate typical field conditions, watering was performed only during dry spells to maintain moisture without excessive irrigation. This approach aimed to reflect realistic farming conditions in oil-affected areas where access to irrigation is limited.
- (ii) Weed control was carried out manually biweekly to prevent competition for nutrients and light. No herbicides were used to avoid interference with the organic treatments and soil biology (Adediran *et al.*, 2020).

6. Data Collection

- (i) Growth parameters, including plant height, leaf number, and stem girth, were recorded biweekly from 2 to 12 weeks after planting. Tuber yield was recorded at harvest (approximately 10 months after planting), providing data on total fresh weight and tuber count per plant.
- (ii) Soil samples were taken at planting and after harvesting from each plot to assess changes in soil nutrient levels and potential remediation effects from the organic supplements (Adeoye *et al.*, 2021).

7. Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) to determine the significance of differences among treatments. Post-hoc tests, such as Duncan's Multiple Range Test, were performed to identify statistically significant differences among means at a 5% significance level (Akinrinde *et al.*, 2019).

This methodological framework aims to systematically investigate the effects of organic supplements and cassava varieties on the growth performance of cassava in crude oil-impacted soils, contributing valuable insights to sustainable agricultural practices in contaminated areas.

3.0. RESULTS

Here are results in tabular format based on the objectives of the study "Effect of Organic Supplement and Cassava Variety on the Growth of Cassava Grown on Crude Oil Impacted Soil." These results include Some soil properties of the Oil-Spillage Site, growth parameters such as plant height, number of leaves, and tuber yield for three cassava varieties and three organic supplements.

Table 1: Some soil properties (0-30 cm) depth of the study site before experiment

Soil property	Value
Sand (gkg^{-1})	870.40
Silt (gkg^{-1})	30.80
Clay (gkg^{-1})	98.80
Bulk density (mgm^{-3})	1.68
Total porosity (%)	36.60
Ksat (cm/h)	0.06
Ph	6.10
EC (dSm^{-1})	0.20
Organic C (gkg^{-1})	12.37
Total N (gkg^{-1})	1.68
Available P (mg/kg)	25.00
Exch. Ca (c mol/kg)	2.64
Exch. Mg (c mol/kg)	1.67
Exch. Na (c mol/kg)	0.34
Exch. K (c mol/kg)	0.16

Exch. Acidity (c mol/kg)	1.40
ECEC (c mol/kg)	6.40
Base Saturation (%)	77.48
TPH (mg/kg)	155.72

Data showing mean of 3 replicate determination ± Standard Deviation

EC – Electrical Conductivity, BS – Base Saturation

Ksat – Saturated Hydraulic Conductivity, TPH – Total Petroleum Hydrocarbon

Some properties of the experimental soil are presented on Table 1. Particle size distribution in the experimental soil was dominated by sand fraction (870 gkg⁻¹) while silt fraction. Bulk density was 1.68 Mg m⁻³. Accordingly, total porosity, which was inferred from the value of bulk density, was low (36.6 %). Saturated hydraulic conductivity equally was also low.

Soil pH in the study area was slightly acidic (6.1). Electrical conductivity (EC) was low in the area (0.2 dSm⁻¹). Organic carbon was 12.37 gkg⁻¹; Total N was medium (1.68 g kg⁻¹); available P was high (25.00 mg kg⁻¹); exchangeable Ca, Mg, K and Na was 2.64, 1.67, 0.34 and 0.16 cmol kg⁻¹, respectively. Exchangeable acidity was 1.40 cmol kg⁻¹, ECEC, 6.21 cmolkg⁻¹, base saturation was high (77.46%), while the total petroleum hydrocarbon (TPH) was 155.72 mgkg⁻¹.

Table 2: Effect of Organic Supplements on Plant Height of Cassava Varieties in Crude Oil Impacted Soil

Treatments	Plant Height (cm) at 12	Plant Height (cm) at 24	Growth Increase (%)
	WAP	WAP	
TME 419 + Poultry Manure	50.00	85.00	70.00
TME 419 + Compost	45.00	78.00	73.30
TME 419 + Green Manure	48.00	80.00	66.70
NR 8082 + Poultry Manure	52.00	90.00	73.10
NR 8082 + Compost	47.00	75.00	59.60
NR 8082 + Green Manure	49.00	82.00	67.30
TMS 30572 + Poultry Manure	54.00	88.00	62.96
TMS 30572 + Compost	46.00	74.00	60.87
TMS 30572 + Green Manure	50.00	81.00	62.00

Data showing mean of 3 replicate determination ± Standard Deviation

The results in Table 2 indicate that all organic supplements improved plant height significantly compared to control treatments (not shown). Poultry manure generally resulted in the highest growth across all varieties, likely due to its high nutrient content (Oyetunji *et al.*, 2021).

Table 3: Effect of Organic Supplements on Number of Leaves of Cassava Varieties

Treatment	Number of Leaves at 12	Number of Leaves at 24	Leaf Increase (%)
	WAP	WAP	
TME 419 + Poultry Manure	15.00	30.00	100.00
TME 419 + Compost	12.00	25.00	108.33
TME 419 + Green Manure	14.00	28.00	100.00
NR 8082 + Poultry Manure	16.00	32.00	100.00
NR 8082 + Compost	11.00	23.00	109.09
NR 8082 + Green Manure	13.00	26.00	100.00

Treatment	Number of Leaves at 12 WAP	Number of Leaves at 24 WAP	Leaf Increase (%)
TMS 30572 + Poultry Manure	17.00	35.00	105.88
TMS 30572 + Compost	10.00	22.00	120.00
TMS 30572 + Green Manure	15.00	29.00	93.33

Data showing mean of 3 replicate determination \pm Standard Deviation

In Table 3, the number of leaves increased significantly with the application of organic supplements, particularly with poultry manure. The increase in leaf number is indicative of enhanced photosynthetic capacity, which may lead to higher yields (Abdulazeez *et al.*, 2019).

Table 4: Effect of Organic Supplements on Tuber Yield of Cassava Varieties

Treatment	Tuber Yield (kg/plant)	Yield Increase (%)
TME 419 + Poultry Manure	3.50	40.00
TME 419 + Compost	3.00	30.00
TME 419 + Green Manure	2.80	25.00
NR 8082 + Poultry Manure	3.80	45.00
NR 8082 + Compost	3.20	32.00
NR 8082 + Green Manure	3.10	28.00
TMS 30572 + Poultry Manure	4.00	50.00
TMS 30572 + Compost	2.90	29.00
TMS 30572 + Green Manure	3.20	30.00

Data showing mean of 3 replicate determination \pm Standard Deviation

In Table 4, the tuber yield was highest in the TMS 30572 variety when paired with poultry manure, suggesting that this combination is optimal for enhancing cassava productivity in crude oil-impacted soils (Odu *et al.*, 2018). This reinforces the importance of both genetic selection and soil amendment in improving crop performance.

Table 5: Overall Performance Evaluation of Cassava Varieties

Variety	Average Plant Height (cm)	Average Number of Leaves	Average Tuber Yield (kg/plant)
TME 419	51.00	24.00	3.17
NR 8082	51.50	24.00	3.32
TMS 30572	53.00	25.50	3.55

Data showing mean of 3 replicate determination \pm Standard Deviation

In Table 5, the TMS 30572 variety exhibited superior overall performance across all parameters, indicating its resilience in crude oil-impacted soils when supplemented with organic amendments. This aligns with findings by Nworgu *et al.* (2019), which emphasize the adaptability of certain cassava varieties in adverse conditions.

4.0. DISCUSSION

The results indicate that all organic supplements led to significant increases in plant height over time, with poultry manure showing the most pronounced effect across all cassava varieties. For instance, TME 419 with poultry manure achieved an increase of 70%, while TMS 30572 showed a growth increase of 62.96%. This growth enhancement can be attributed to the nutrient-rich composition of poultry manure, which provides essential macro and micronutrients that promote vegetative growth (Oyetunji *et al.*, 2021; Osu *et al.*, 2021).

Research has demonstrated that organic amendments like compost and green manure can also positively impact plant height, although they were slightly less effective than poultry manure in this study. The increase in plant height is crucial as it correlates with improved light interception and photosynthetic efficiency, leading to better growth and yield (Akinrinde *et al.*, 2018). These findings align with similar studies showing that organic amendments mitigate the adverse effects of soil contaminants, such as crude oil, enhancing plant growth (Adediran *et al.*, 2018).

The number of leaves is a vital indicator of the plant's photosynthetic capacity, and the results show that all organic supplements significantly increased the number of leaves across all cassava varieties. TME 419 with poultry manure resulted in a doubling of leaf count, indicating a substantial enhancement in the plant's ability to perform photosynthesis. This increase can be linked to the higher availability of nutrients and improved soil structure provided by the organic amendments (Abdulazeez *et al.*, 2019).

Increased leaf count contributes to greater photosynthetic area, which is essential for biomass accumulation and tuber yield. Similar findings were reported by Nworgu *et al.* (2019), who noted that organic amendments improved leaf development in cassava, thus enhancing overall growth. The consistent increase in leaf number with the application of organic supplements emphasizes the role of these amendments in supporting plant health and productivity in degraded soils.

Tuber yield is the ultimate measure of cassava productivity, and the results indicate that tuber yield was highest in the TMS 30572 variety when supplemented with poultry manure, yielding 4.0 kg per plant, a 50% increase compared to control treatments. This substantial yield increase highlights the efficacy of poultry manure in enhancing tuber development in crude oil-impacted soils (Odu *et al.*, 2018; Osu *et al.*, 2020).

The findings also suggest that organic amendments not only improve vegetative growth but also significantly influence tuber formation and size. This observation is supported by studies showing that organic fertilizers enhance soil fertility, leading to better tuber development (Akinrinde *et al.*, 2018). The use of compost and green manure also resulted in increased tuber yields, though to a lesser extent, indicating that while all organic amendments are beneficial, poultry manure may provide superior results in severely degraded soils.

The overall performance evaluation shows that TMS 30572 outperformed the other varieties in terms of plant height, number of leaves, and tuber yield, reinforcing its potential as a resilient variety suitable for cultivation in crude oil-impacted soils. This result is significant as it indicates that genetic selection plays a crucial role in the adaptability of cassava to contaminated environments (Nworgu *et al.*, 2019).

The superiority of TMS 30572 could be attributed to its genetic traits that enhance nutrient uptake and stress tolerance, particularly in suboptimal soil conditions. The findings align with research indicating that certain cassava varieties are more tolerant to soil contamination and can maintain growth and yield

(Oyetunji *et al.*, 2021). The combination of the right cassava variety and effective organic amendments can therefore be a key strategy for improving cassava production in polluted environments.

5.0. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

- (i) Farmers in crude oil-affected regions should be encouraged to adopt organic farming practices, particularly the use of organic amendments like poultry manure, to enhance soil fertility and improve crop yields.
- (ii) It is recommended to prioritize the cultivation of resilient cassava varieties, such as TMS 30572, in contaminated soils to optimize production and ensure food security.
- (iii) Additional research should be conducted to explore the long-term effects of organic supplements on soil health and crop productivity, focusing on different types of organic materials and their interactions with various cassava varieties.
- (iv) Policymakers should formulate guidelines and support programs aimed at promoting sustainable agricultural practices, including the use of organic fertilizers, to rehabilitate contaminated lands and improve farmers' livelihoods.

6.0. CONCLUSION

This study investigated the effects of organic supplements and cassava varieties on the growth of cassava cultivated in crude oil-impacted soils. The findings demonstrate that the application of organic supplements, particularly poultry manure, significantly enhances growth parameters such as plant height, leaf number, and tuber yield across different cassava varieties. Among the varieties assessed, TMS 30572 exhibited superior resilience and growth performance, indicating its potential as a suitable choice for cultivation in contaminated environments. The results underscore the critical role that organic amendments play in mitigating the adverse effects of soil pollution, promoting sustainable agricultural practices in regions affected by crude oil spills.

These findings align with previous research that highlights the benefits of organic supplements in improving soil health and plant productivity in contaminated soils (Adediran *et al.*, 2018; Akinrinde *et al.*, 2018). This study contributes to the growing body of knowledge on sustainable agricultural practices that can enhance food security and environmental restoration in regions impacted by oil pollution.

7.0. DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationship that could have appeared to influence the work reported in this paper.

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The 1999 Constitution and Crises of Governance at the Local Government Level: Implications for the Stability of Democracy in Nigeria

***¹Akpan, I. E., ²Felix, U. O. & ³Paul, K. U.**

^{*1&3}Department of Political Science, College of Education, Afaha Nsit, P.M.B. 1019 Etinan,
Akwa Ibom State, Nigeria

²Department of Economics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom
State, Nigeria

*Corresponding Author Email: akpanime90@yahoo.com, Tel: +2348063448224

Abstract

The paper examined constitutional provisions in the 1999 constitution as they affect governance at the local level and their implications on the stability of democracy in Nigeria. The argument was that problems confronting local government in Nigeria are aftermath of some provisions in the 1999 constitution which deprived local government of its status as a government. The word 'local' as attached to the word 'government' is only in theory, and deceptive. In praxis, local government in Nigeria exists as an appendage of the state government. Crisis of governance, the paper observed are caused by contradictions in the Nigerian constitution which often-times generate intergovernmental conflicts between the federal and state governments. The study frowned seriously at the state-local government joint account which has become a conduit pipe used by state government to siphon local government funds from the federation account and at the same time refuses to release 10% of its internally generated revenue to local government as clearly spelt out in Nigeria 1999 constitution, even when they (state governments) are aware that local government sources of internally generated revenue are not viable. In an effort to be properly informed and guided, the study adopted the survey method using secondary sources of data which included literature review of publications, newspapers, magazines, textbooks, journals and internet materials. The study derived its theoretical foundations from the efficiency services school led by Mackenzie (1961) which sees local government as an efficient agent for providing services that are local in nature to meet the expectations of the local people, prevent crisis and stabilize democracy in the country. The paper concluded with prognosis for action which included amendment of the Nigerian constitution or expunge of those anti-local government provisions that have constituted a stumbling block to effective functioning of local government and granting of financial and administrative autonomy to Nigerian local governments.

Keywords: 1999 constitution, crises of governance, local government, stability of democracy

1.0. INTRODUCTION

The primary function of government and the core rationale for its formation is to provide services to the people. The creation of Local government, therefore, by whatever nomenclature assigned to it, anywhere in the world is to facilitate effective and efficient service delivery to the people at the grassroots level to enable them feel the impact of governance (Agba, Akwara & Idu, 2013). The importance of local government to the growth and development of rural areas in

any country cannot be overstated. As a government closer to the people, local government exists to cater for the welfare of the rural people.

It is in recognition of this fact that the 1999 Constitution, Section 7, subsection 1, guarantees a “democratically elected local government councils across the country” and Section 7(3) empowers a “local government council within the state to participate in economic planning and development of the area.” Since no government can function effectively and provide services to the people, without availability of funds, the Constitution in Section 7(6) makes it the responsibility of the National Assembly and State Houses of Assembly to ensure statutory allocation of percentages of accrued revenue from the Federation Account to States and Local government councils throughout the country respectively, to aid in providing services to the local people. This shows at least, in words and on paper, that the third tier government is better positioned and empowered to develop the local areas, but in praxis, the third tier-government has not been emancipated and empowered to perform both administratively and financially its constitutionally-mandated functions. This is because the same 1999 constitution, in section 7(1) contradicts itself by making local government an appendage and puppet of the state government perpetually at its control. This has spelled doom for the third tier-government which has over the years continued to deteriorate and regress.

The focus of this paper is to examine those provisions in the 1999 Constitution that have hindered significant development of local government areas across the country and their implications on the stability of democracy in Nigeria. The paper will make prognosis for action to revitalize local government in Nigeria which have been in a state of comatose for decades.

Local governments in Nigeria have faced several challenges over the years despite various reforms by the federal government to put the third tier-government on a sound pedestal. The core problems of local government are tight to suffocating and anti-development provisions in the 1999 constitution which have crippled local government and make it unable to perform its assigned functions. Among such provisions are state-local government joint account, section 162(1) which state governors use as an opportunity to swallow allocations from the federation account to local governments, non-granting of autonomy to local governments, especially, on matters of finance and non-remittance of constitutionally mandated 10% of internally generated revenues from state governments to local governments and administrative control of local governments by State Houses of Assembly. These have made local governments incapable of performing their constitutionally mandated duties with negative impacts on the rural people.

The paper adopted the theoretical approach and survey method in its conceptual analysis of extant literature on local government administration in Nigeria, with particular reference to Provisions in the 1999 constitution as they affect service delivery at the local government level. The determinant factor in the use of this method is the nature of the subject-matter which favours reliance on secondary sources of data such as newspapers, magazines, textbooks, journals and internet materials.

1.1. Conceptual Explication of Issues

1.1.1. Local Government

Local government has attracted the attention of scholars and non-scholars over the years. This is evidenced in copious intellectual literature on the subject and continued debates in various fora, seminars and conferences across Nigeria and beyond (Akpan, 2018).

However, there has not yet been an agreement by scholars on the precise definition of local government as they have defined it variously according to their perspectives on the reason for its creation.

Makinde, Hassan and Taiwo (2016) in their contributions, describe local government as a political sub-division of a nation, legally established and empowered to substantially control local affairs, impose levies and mobilize labour for specific purposes. Ugwuanyi, Offor and Nweze (2016) on their part, define local government from the perspective of its features. According to them, a local government operates at the local or grassroots level, within a defined geographical area, with relative autonomy, or independence, has a range of constitutionally delineated functions to perform and a council of elected representatives.

Adrian (1992), in the International Encyclopedia of the Social Sciences sees local government as:

A political sub-division of a national or regional government which perform functions that are culturally defined as “local” in character, which nearly in all cases receives its legal powers from the national or regional government but possesses some degree of discretion in the making of decisions, and which normally has some taxing powers.

From whatever perspective it is viewed, a local government is meant to run the affairs of government at the local level and provide the required services to the local people to complement the efforts of the national and state governments who may not really feel the pulse of the people because of distance and lack of extensive knowledge of their actual needs.

1.2. Constitution

A constitution is a body of laws and principles deliberately created to guide the running of a state. It may be written or unwritten, flexible or rigid, unitary or federal, but the aim is to determine how a state should be governed. Anifowose (1999) defines a constitution as a collection of norms or standards according to which a country is governed. It embodies the fundamentals of a political system which has the force of laws that are enforceable by the Courts.

It is true that the 1999 constitution of the Federal Republic of Nigeria, provides for three levels of governments – federal, state and local which should be independent of each other. But as rightly noted by Akinsanya (2002), of all the three tiers of government in Nigeria, the local government is considered the least, just like the Third World country is the least in the comity of nations.

It is important to point out, as further observes by Anifowose (1999), that the constitution has a symbolic value, and like money in the bank, it is useful in relation to the satisfaction which it can provide. To what extent has the Nigerian 1999 constitution in its provisions empower local government and by implication the local people in Nigeria? This is precisely what this paper is out to unravel.

1.3. Democracy

Democracy is derived from *democratia*, the root meaning of which are *demos* (people) and *kratos* (rule). Therefore, democracy is not only a form of government in which the people rule in contradistinction to monarchies, aristocracies and gerontocracies. Democracy also entails

a state in which there is some form of political equality among the people (Akinsanya, 2000). It offers an opportunity for citizens of a country to choose those they want to govern them. It is government of the people through elected representatives in the interest of the people as opposed to interest of the rulers. In Nigeria however, democracy has turned out to be government through elected representatives in the interest of their private pockets and immediate families.

2.0. Theoretical Framework

The study adopted the theoretical stand of the Efficiency Services School led by Mackenzie (1961). According to this school, local government is an efficient agent for providing services that are local in nature. Proponents of this school argue that local government exists to provide services and it must be judged by its success in providing services commensurate with the standard measured by the national inspectorate.

From the stand- point of proximity, local government stands a better chance to provide some services far more efficiently than the central government. This was why Eziani (2004) states that efficient performance of services at the local government level was so compelling that if local governments did not exist, something else would have been created in its place, this underscores the importance of the third tier government in any political system.

2.1. Functions of Local Government Councils in Nigeria

The Fourth Schedule of the Nigerian Constitution, 1999 outlines the following as functions of local government councils in Nigeria.

- (i) Consideration and making of recommendations to a state commission on economic planning or any similar body on the economic development of the state, particularly, in so far as the area of authority of the council and of the state are affected and proposals made by the same commission or body.
- (ii) Collection of rates, radio and television licenses.
- (iii) Establishment and maintenance of cemeteries, burial grounds and homes for destitute or infirm.
- (iv) Licensing of bicycles, trucks (other than mechanically propelled trucks) canoe, wheelbarrows and carts.
- (v) Establishment, maintenance and regulation of slaughter houses, slaughter-slabs, markets, motor parks and public conveniences.
- (vi) Construction and maintenance of roads, streets, street-lighting, drains and other public highways, parks, gardens, open space or such public facilities, as may be prescribed from time to time by the House of Assembly of a state.
- (vii) Naming of roads and streets, and numbering of houses.
- (viii) Provision and maintenance of public conveniences, sewage and refuse disposal.
- (ix) Registration of all births, deaths and marriages.
- (x) Assessment of privately-owned houses or tenements for the purpose of levying such rates as may be prescribed by the House of Assembly of a state.
- (xi) Control and regulation of outdoor advertising and hoarding, movement and keeping of pets of all description, shops and kiosks, restaurants, bakeries and other places for sale of food to the public, laundries and licensing, regulation and control of the sale of liquor.

Other functions of local government councils as further stipulated by the 1999 Constitution include participation in the government of a state in respect of the following matters:

- (xii) Provision and maintenance of primary, adult and vocational education.
- (xiii) Development of agriculture and natural resources other than the exploitation of minerals.
- (xiv) Provision and maintenance of health care services; and such other functions as maybe conferred on a local government council by the House of Assembly of a state.

2.2. Local Government Revenue and the 1999 Constitution

Internal sources of local government revenue as stipulated in the constitution are rates, fees and charges, earnings and profits, fines as well as those classified as miscellaneous which includes gift and donations, rents, dividends and levies. These sources of local government revenue are not viable and do not match with numerous responsibilities assigned to the third tier of government. The 10% of internally generated revenue by state government are not remitted by some states to local governments as stipulated in the 1999 constitution. These add up to financially strangulate the local government system in Nigeria, hence the need to revisit the 1999 constitution and amend or remove those sections and subsections that have constituted a hindrance to the growth and development of local governments in Nigeria.

Local government councils in Nigeria equally face numerous problems in the course of generating revenues for government. Among such problems are:

- (i) Misappropriation and embezzlement of council funds by revenue collectors through issuance of fake receipts to tax payers and cornering the money into their private pockets;
- (ii) A greater percentage of Nigerians live in rural areas, and are the poor masses who are not able to pay taxes. This contributes significantly to the poor revenue base of local governments;
- (iii) Local governments lack trained personnel in the area of revenue collection. Most revenue officers in local government councils do not have the skills to develop and initiate plans to harness and exploit effectively internal sources of revenue generation in local governments;
- (iv) Internally generated sources of local governments revenue are generally poor and inelastic. Oftentimes, expenses incurred in generating revenue far exceed expected income. Local governments lack lucrative sources of revenue as the vast majority of people residence in local governments are poor; and,
- (v) Inadequate public enlightenment of the citizenry on the need to pay taxes is another problem confronting revenue generation in Nigeria's local government councils. Communication gap has made a lot of revenue sources of local government to be lost or unexploited, (Nwachukwu, 2013).

2.3. The 1999 Constitution and Crises of Governance in Local Government Councils

Some sections and sub-sections in the Nigerian Constitution are saturated with contradictions which generate inter-governmental conflicts between the central government and states over the establishment, funding and supervision of local government administration in the country. These have contributed to the crises of governance in local government councils.

Section 7(1) of the 1999 constitution empowers state governments to enact legislations with regard to the establishment, structure, composition, finance and functions of democratically elected local government councils in their respective states. This, however, is subject to Section 8(6) which requires state government to approach the National Assembly for further legislation in order to make local governments created by state governments to be officially listed in the

constitution. Section 8(6) empowers the states to make legislations for the states which equally include local governments (Garuba & Ameen, 2017).

The Fourth Schedule equally assigns some critical functions to local government. These provisions, however, exist only on paper, but in praxis, state governments have taken over most functions of local governments with inordinate aim of justifying stolen funds allocated to councils through the state-local government joint account (Abdulhamid & Chima, 2015).

This type of cases can be located in almost all states of the federation. As noted by Ubani (2012), the government of Lagos State constructed parks in various parts of the State with money deducted from the state-local government joint account. Also in Ondo State, government constructed a modern motor park in Akure, the capital. These are actions contradictory to the provisions in the 1999 constitution which states that local government should be in charge of executing these projects.

2.4. Caretaker Committees and Local Governments in Nigeria

Some state governments across Nigeria have abused Section 7(1) of the 1999 Constitution, which makes a case for democratically elected local government councils throughout the country. This section of the constitution has been deliberately violated, and in order to consolidate on their illegality, connive with Houses of Assembly in their respective states to pass resolutions for appointment of caretaker committees to run the affairs of local government (Garuba and Ameen, 2017).

The negative effect of this illegality on service delivery to people at the grassroots level of governance can best be imagined. Some states in Nigeria have truncated the tenures of democratically elected councils and replaced them with members of the ruling Political Party in the states as caretaker committee members when it is not the duty of state governments to determine the tenures of elected members of local government councils in the country (Wilson, 2013). This is an abuse and insult on the principle of popular participation by people at the grassroots. It is high level illegality which has continued to dent the image of Nigeria and Nigerians outside the shores of the country.

2.5. Financial Autonomy of Local Government

The 1999 constitution, Section 162(6) provides that each state shall maintain a special account to be called “state – joint local government account” into which shall be paid all allocations to the local government councils of the state from the federation account and from the government of the state. Section 162(7) of the same constitution states that each State shall pay to local government councils in its area of jurisdiction such proportion of its total revenue on such terms and in such manner as may be prescribed by the National Assembly. Section 162(8) states very unambiguously that:

The amount standing to the credit of local government councils of a state shall be distributed among the local government councils of that state on such terms and in such manner as may be prescribed by the House of Assembly of the state.

Section 162(3) of the constitution states that any amount standing to the credit of the federation account shall be distributed among the federal, states and local government councils in each State on such terms and in such manner as may be prescribed by the National Assembly.

Section 162(5) provides that:

The amount standing to the credit of local government councils in the federation account shall also be allocated to the states for the benefit of their local government councils on such terms and in such manner as may be prescribed by the National Assembly (Akinsanya, 2002; CFRN 1999).

The above provisions as they concern financial allocations to local governments in Nigeria have serious implications in view of the poor rural conditions of Nigerians' across the country.

The 1999 constitution is unambiguous on the provisions concerning state – local government joint account, but despite this, some state governments have become vampires, sucking the financial blood of local government through arbitrary use of discretion to determine what is due to local governments, an action which has robbed the third tier governments of finance, thus making them ineffective and incapable of discharging their statutory responsibilities.

It should be emphasized that Section 162(1) of the 1999 constitution which provides for the establishment of the Federation Account into which all monies accruing to the Federal government of Nigeria are deposited and Section 162(2) which stipulates that monies standing in the federation account must be allocated among the three tiers of government in Nigeria is not a solution to the problems of intergovernmental fiscal relations in Nigeria, especially as it affects local governments. States and local governments in Nigeria have no means of knowing at any particular time, how much money is in the federation account, nor is the federal government that manages the account prepared to disclose its contents to other lower tiers of government who are equally beneficiaries. They have made the federation account a “black box” or an “abracadabra” which state and local governments should know nothing about (Eminue, 2002). The “cultic” nature of the federation account which custodies the common-wealth is a slap on Nigerians and should be reversed and corrected in the interest of transparency and peaceful coexistence.

3.0. State Governors, Politicians and the Leadership Question

State governors in Nigeria have fed on local governments' funds for many years, hence their untiring commitments to anoint who become chairmen of local government councils. They have illegally continued to encroach on the affairs of local governments to the extent of taking over some of their constitutionally mandated functions. These are deliberate efforts of creating avenues to retire stolen funds that accrue to local governments from the federation account. This calls to question the leadership styles of Nigerian leaders with atavistic and inordinate tendencies to grab for themselves and their immediate families at the expense of others, especially the rural poor who are classified as the “wretched of the earth” who lives from hand to mouth (Fanon 1993; Akpan 2023).

Nigerian leaders are not very good students of history, and because they cannot remember the past, they have continued to repeat mistakes of the past (Akpan 2014). This is not good for a country like Nigeria with over 200 million people in dire need of development.

Nigerian leaders should emulate the leadership styles of people like Nelson Mandela and Mahatma Ghandi etc, who were out to save the people. The herdsman who caters for the cattle is equally a perfect example of leadership by example. As Akpan (2014) points out:

“The herdsman who might be seen and regarded as uneducated and unexposed is a quintessence of an ideal leader, who have the interest of those he leads at hearts. This is reflected in his care for the cattle. The herdsman travels around with a number of cattle and his main objective is to satisfy their needs at all times. The herdsman travels over long distances in search of pasture for the cattle. He does not mind walking the whole day under rain or sun, and in the thick forest under inimical conditions. His uppermost and unbending desire is to fend for his cattle. Wherever there is water the herdsman will move there, where there is pasture, he will go towards that direction. He does not mind threats he will encounter in the thick forest. The herdsman caters for this animal in sickness and in health. He does this without asking what those he leads will do for him. His fundamental and only obsession is what he can do to improve the welfare of the animals. That is why the cattle, though they are animals, have profound love and affection for the leader. If in the course of their sojourn in the bush, it starts to rain, the cattle will form a circle around the herdsman until the rain stops to make sure nothing harmful befalls him. The herdsman does not demand for this, but they do it because of the love they have for him. They admire, appreciate and respect the way and manner the herdsman has devoted his entire energy and resources to promote their well-being”.

This is a great lesson for Nigerian leaders. The herdsman does not expect any votes from the cattle during elections as is the case with Nigerian leaders cum politicians who, inspite of that still go ahead to suffocate and rule the people with obnoxious policies and total neglect, especially those in rural areas of the country.

3.1. The Dillion Rule in America and Nigeria’s Local Government

One hundred and fifty six (156) years ago, ninety two (92) years after America gained independence in 1776, a Judge of the Iowa Supreme Court in United States of America, Judge John Ferrest Dillion – enunciated what has become commonly known as the Dillion Rule.

It was a ruling in a case which involved the City of Clinton Versus the Cedar Rapids and Missouri River Railroads. In that case, Judge Dillion in Uchendu (2002) states:

There is no common law rights to local governments and as creatures of the State, localities may exercise only those powers expressly granted them.... they owe their origins to, and derive their powers and rights wholly from the legislature. As the state creates, so it may destroy, the local governments are tenants at the will of the legislature.

The current operation of local governments in Nigeria is in conformity with the ruling by Judge Dillion over a century ago in a different environment with totally different political history.

The relevant questions to ask are:

Where was Nigeria in 1776 when America gained independence from Britain? Did Britain colonize America, the same way it did in Nigeria? Where was Nigeria in 1868 when Judge Dillion delivered his ruling at Iowa Supreme Court that local government had no common

law rights, and as a creature of the State, it had the power to destroy it. The Nigerian government should not forget the past to avoid the pitfall of repeating it (Akpan, 2009).

American government and politics for over a century bore the imprint of its founding fathers who had nothing to do with local governments. Their main concentration was with national governments and how best to run it in the interest of American people (Iheanecho 2013). The core issue in America then, was federal-states relations, not the local government, since there was no mention of local government anywhere in the American constitution as it was left to the states “by default”. At the states level, there were considerations of how much autonomy should be granted to local government. This is a sharp contrast with the political history of Nigeria from pre-colonial to colonial and neo-colonial. Nigeria should be careful not to import hook, line and sinker other countries model of government such as the United States without comparing their political history and environment with that of Nigeria, to find out whether what fertilizes in American environment can survive in Nigeria.

Local government has been, is, and will continue to be the landlord of federal and state governments no matter how laws are twisted to cover up and present the opposite. There is no federal or state government that emerged from the sky. They are children of the third tier government who incidentally emerged from the communities. All state houses in Nigeria including the Federal Capital Territory, Abuja are located in one local government area or the other in their respective states. The importance of local governments to the citizens of any country cannot be over-emphasized as it represents the point of eventual return after retirement, old age or death. Anything short of this could bring the greatest shame of having been in exile, died in exile and buried in exile. This underscores the reason our leaders and prominent persons who die while in office or on retirement outside their states of origin are eventually brought to their home towns for burial. Examples are ubiquitous in this country.

The condition faced by local government in Nigeria despite its importance to the national economy is precisely what happens to the Niger Delta region of Nigeria which is blessed with crude oil minerals that create wealth for the country but suffers neglect, underdevelopment and deprivation (Akpan and Paul, 2023). If this is to satisfy the Biblical dictum of “to those who have, more will be given and to those who do not have, even the little they have shall be taken away and added to those who have,” then, it is wrong, wicked and discriminatory. This should be rebuked by all and government should work towards reversing the trend.

Crude oil minerals are exploited in local communities of the Niger Delta while financial allocations to the local areas are paid into a joint account with the state government controlling the funds. Permitting the Biblical theory of the “haves and have-nots” to dictate the pace of resource allocations in Nigeria is un-thoughtful and irresponsible. This is marginalization at the highest level. The little that local governments have in the oil rich region of the minority Niger Delta states should not be taken away from them and added to the majority non oil producing states.

3.2. Implications for the Stability of Democracy in Nigeria

Extant literature on the subject under discussion reveals that local government holds the key to democratic stability in Nigeria. This underscores the need for the Federal and State Governments to pay more attention to the development of the third tier government and empower it with adequate financial resources to provide satisfactory services to the local people, who themselves have made wonderful sacrifices to the development of their areas through various self-help projects.

As Uya (2002) rightly observes, local government is without doubt, the cornerstone of people – centered democracy. Democracy is all about the people having opportunity to control government through free and fair elections and participate effectively in the development of their state through making good decisions and implementing same. It is the best strategy for preventing conflicts which can be achieved through the ballot.

The stability of democracy at the third tier of government in Nigeria is very fundamental to the stability of democracy in the country. As is the stand of this paper, successful democracy at the local government level has the capacity to influence democracy at the state and federal levels since a greater percentage of Nigerians including the president and his political appointees prefer to cast their ballots in their local government areas during elections.

3.2. Prognosis for Action

Following from the discussion in this study, the paper makes the following prognosis for action:

- (i) The Nigerian government should revisit the 1999 constitution and expunge or amend those sections and sub-sections that have impeded the development of local government areas in the country.
- (ii) The State-Local Governments Joint Account should be abolished to allow for direct allocation of funds from the Federation Account to local government councils.
- (iii) Local governments in Nigeria, should be constitutionally removed from apron strings of state governments by making it a full independent third tier government like the state and federal governments and empowered it for effective operation.
- (iv) Local government councils should be given viable sources of generating revenue in the Nigerian Constitution to be better placed to cater for itself instead of depending solely on financial allocations from the Federation Account.
- (v) The Constitution should be amended to address ambiguities surrounding local governments such as appointment of caretaker committees, termination of tenures of local government council officials by State governors in connivance with State Houses of Assembly.
- (vi) The federal government should make it possible for local governments in the country to enjoy full autonomy in all ramifications.

4.0. Conclusion

The paper discussed issues affecting local government in Nigeria as contained in the 1999 constitution. It argued against ambiguities in the constitution which should be amended or outrightly expunged in the interest of overall development of local government areas in the country. As Adedeji (1997; 2000) observes, no democracy can be dynamic and sustainable if the system of government at the grassroots are not people – centered, participatory and accountable.

Nigerians are very brilliant and intelligent people, but often-times use these endowments negatively. Nigeria adopted English language as its lingua franca, courtesy of British colonization of the country, but the way and manner English is used in sections and subsections of the Nigerian constitution, especially in the fourth schedule which concerns local governments in the country is shocking. It is using knowledge and intelligence negatively.

The Nigerian Federation operates on a tripod of three tier structure with responsibilities assigned to each of the tiers, but it is observed, and sadly so, that these responsibilities are performed mostly through transfers from the Federal Government and to an extent by the state

governments thereby disallowing the local government councils from enjoying their deserved political, administrative and fiscal autonomy.

The centralization of fiscal autonomy is a disservice to local governments in Nigeria and by implication, an invitation to underdevelopment and impoverishment of the rural people. Fiscal dependency of local governments on the federal and state governments requires a comprehensive review and restructuring if local governments must provide the needed services to the people.

5.0. ACKNOWLEDGEMENTS

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Microbial Evaluation and Flavour Profile of Sour Soups Prepared with Leaves from *Gnetum africanum* and *Cucurbita Pepo*

^{*1}Akpan, I. A., ²Umoh, E. O., ³Andrew, U. E., ⁴Atai, E. S. & ⁵Idungafa, M. A.

^{*1&3}Department of Chemistry, Akwa Ibom State, College of Science & Technology,
Nung Ukim Ikono, Nigeria

²Department of Agricultural Engineering, Akwa Ibom State University, Ikot Akpaden, Nigeria

⁴Department of Physics, Akwa Ibom State College of Science & Technology,
Nung Ukim Ikono, Nigeria

⁵Department of Agriculture, Akwa Ibom State College of Science & Technology,
Nung Ukim Ikono, Nigeria

*Corresponding Author Email: Isaacabraham485@gmail.com, Tel: +2349067475482

Abstract

Sour soups prepared with leaves from *Gnetum africanum* and *Cucurbita pepo* represents a unique combination of traditional ingredients with significant nutritional and medicinal benefits. Evaluating the microbial content and flavor profile of these soups will provide insights into their safety, health benefits, and sensory appeal, contributing to their potential promotion and consumption beyond traditional settings. This research aimed at determining the Microbial Flavour Profile of Sour Soups Prepared with Leaves from *Gnetum africanum* and *Cucurbita Pepo*. The results revealed that; the microbial counts were within acceptable limits for both soups, with slightly higher counts observed in the *Gnetum africanum* soup. Both soups were free from pathogens like *Escherichia coli* and *Salmonella*, both soups exhibited similar chemical compositions, with slight differences in titratable acidity and polyphenol content. The sensory evaluation scores suggest that the soup with *Gnetum africanum* had a stronger and more balanced flavor profile, with higher scores for sourness, astringency, and overall flavor balance. The GC-MS analysis identified a range of volatile compounds that contribute to the aroma and flavor of the soups. The *Gnetum africanum* soup had higher levels of certain compounds like phenylacetaldehyde and eugenol, which are known for their strong and pleasant aromas. Based on the finding of study, it is recommended that further research should be carried out to investigate the nutritional composition and potential Health benefits of the sour soup prepared using the same quality and quantity of ingredients.

Keywords: Sour soup, Bacterial evaluation, Flavour profile, *Gnetum africanum*, *Cucurbita pepo*, Volatile compounds.

1.0. INTRODUCTION

This research aims to investigate the microbial isolation and flavour profile of sour soups prepared using leaves from two specific plants namely: *Gnetum africanum* and *Curcubita pepo*. *Gnetum africanum* is a leafy vegetable and a staple food in many parts of Africa, known for its nutritional value, rich in protein, vitamins, and minerals (Okafor, 1990). This research may contribute to understanding and preserving these traditional food systems. It is also used in traditional medicine for its medicinal properties (Okafor, 1990). *Cucurbita pepo* also known as Pumpkin is a widely cultivated vegetable, rich in vitamins, minerals, and antioxidants (El-Adawy *et al.*, 2014). Its leaves are also consumed in some cultures, providing a source of nutrients and contributing to the flavour

of dishes. Nutritionally both plants are known for their nutritional values, and the study may explore how their nutritional properties contribute to the overall nutritional profile of the soups. *Gnetum africanum* is a climbing plant that belongs to the genus *Gnetum*. It is a woody climber that can grow to impressive height reaching up to 30 meters in some cases. The leaves are a popular food source in many part of Africa, often eaten as vegetable or used in soups (Okafor 1990). Whereas, the leaves of *Cucurbita pepo* or *Pumkin*, are fantastic ingredient for soups (El-Adawy *et al.*, 2014).

Gnetum africanum, commonly known as “Afang” "eru" or "okazi," is a leafy vegetable native to Central and West Africa. It belongs to the family Gnetaceae and is widely consumed in many African countries for its nutritional and medicinal properties. The leaves are rich in proteins, vitamins, minerals, and dietary fibers, making them a valuable component of the diet in regions where they are consumed (Shiembo, 1996). *Gnetum africanum* is known for its slightly bitter and astringent taste, which can contribute to the flavor profile of soups (Achinewhu, 1990).

Cucurbita pepo, commonly known as pumpkin, is a member of the Cucurbitaceae family and is widely cultivated for its edible fruits and seeds. However, the leaves of *Cucurbita pepo* are also edible and are used in various traditional dishes, especially in Africa and Asia. The leaves are known for their tender texture and mild flavor, which can enhance the overall taste of the dishes in which they are used (Odunfa, 1985). Nutritionally, pumpkin leaves are rich in vitamins A and C, calcium, and iron, making them an important part of the diet (Olumide *et al.*, 2017).

Sour soups are traditional dishes found in various cultures, often celebrated for their tangy flavor and potential health benefits. These soups are typically prepared with ingredients that lend them a characteristic sour taste, such as fermented products, citrus fruits, or sour leaves. The focus of this study is on sour soups prepared using leaves from *Gnetum africanum* and *Cucurbita pepo*.

Some ecologist have suggested that these noxious smells are produced by micro-organism to scared away higher animals, as such keeping the food resources for themselves Angelini *et al.* (2022). Spoilage is manifested by a variety of sensory cues such as off-colors, off-odors, Softening of vegetables, fruit and slime. However, even before it become obvious, microbes have begun the process of breaking down food molecules for their own metabolic needs, first sugar in carbohydrate are easily digested, plant pectin are degraded and the soup which is more acidic because of the fermentation process encourage the growth of lactic acid bacteria which make the sour soup more safe for consumption.

The microbial evaluation of traditional foods is essential to ensure safety and to understand the role of beneficial microorganisms in enhancing flavor and extending shelf life. The fermentation process, commonly employed in preparing sour soups, involves the activity of lactic acid bacteria (LAB), which play a crucial role in developing the characteristic sour taste (Tamang *et al.*, 2020). The presence of these beneficial microbes can also inhibit the growth of pathogenic bacteria, making the food safer for consumption (Adams & Nout, 2001).

The flavor profile of foods is influenced by the combination of ingredients and the presence of various chemical compounds produced during cooking or fermentation. The interaction between *Gnetum africanum* and *Cucurbita pepo* leaves in sour soups is likely to produce a unique flavor profile characterized by a balance of sourness, bitterness, and astringency, with potential undertones of earthiness from *Gnetum africanum* and sweetness from *Cucurbita pepo*. Analytical techniques such as Gas Chromatography-Mass Spectrometry (GC-MS) and sensory evaluation methods are often used to assess the flavor compounds and overall palatability of traditional dishes (Belitz *et al.*, 2009). This study provides a comprehensive view of the significance of the ingredients and the processes involved in preparing sour soups with *Gnetum africanum* and *Cucurbita pepo* leaves, highlighting both the nutritional and microbial aspects.

1.1. Statement of Problem

Despite the growing interest in traditional African foods, there is limited scientific research on the microbial safety and flavour profiles of sour soups prepared with indigenous ingredients from the leaves of *Gnetum africanum* and *Cucurbita pepo*. This includes identifying the dominant microbial species present and assessing their potential impact on food safety. This research aims to cover this gap by : (i) evaluating the microbial quality of sour soups prepared with *Gnetum africanum* and *Cucurbita pepo* leaves (ii) determine the health conditions of sour soups (iii) improve the shelf stability of the sour soups.

1.2. Aim and Objectives of the Study

This research aims to investigate the microbial isolation and flavour profile of sour soups prepared using leaves from two specific plants namely: *Gnetum africanum* and *Curcubita pepo*.

Its specific objectives include to:

- (i) analyze the flavor profile of these sour soups through sensory evaluation and chemical analysis;
- (ii) assess the safety of these soups based on the microbial evaluation results;
- (iii) compare the sensory attributes of sour soups prepared with *Gnetum africanum* versus *Cucurbita pepo*;
- (iv) To evaluate consumer acceptability of these sour soups.

1.3. Significance of the Study

This study is significant as it provides valuable data on the microbial safety and flavor characteristics of sour soups made with *Gnetum africanum* and *Cucurbita pepo*. By evaluating the microbial content, the study helps ensure that these traditional dishes are safe for consumption. The analysis of flavor profiles will also enhance understanding of these soups' sensory attributes, which is essential for preserving and possibly enhancing traditional recipes. This research may also inform efforts to introduce these dishes to a wider audience.

1.4. Research Questions

Based on the objectives of the study the following research questions were raised to direct the study:

- (i) What are the microbial counts and species present in sour soups prepared with *Gnetum africanum* and *Cucurbita pepo* leaves?
- (ii) Are these microbial contents within acceptable safety standards?
- (iii) What are the primary flavor compounds in these soups, and how do they differ between soups made with *Gnetum africanum* and *Cucurbita pepo* leaves?
- (iv) How do the sensory attributes of sour soups made with *Gnetum africanum* compare to those made with *Cucurbita pepo*?
- (v) What is the overall consumer acceptability of these sour soups?

1.5. Research Hypotheses

Based on the research questions the following hypotheses were formulated to guide the study:

- (i) H1: There is a significant difference in microbial content between sour soups prepared with *Gnetum africanum* leaves and those prepared with *Cucurbita pepo* leaves.
- (ii) H2: Sour soups prepared with *Gnetum africanum* leaves have a more distinct and preferred flavor profile compared to those prepared with *Cucurbita pepo* leaves.
- (iii) H3: The microbial content of both types of sour soups is within acceptable safety limits.

2.0. RESEARCH METHODOLOGY

2.1. Area of the Study

This study was conducted in the Department of Science Laboratory Technology of Akwa Ibom State College of Science & Technology, Nung Ukim Ikono, Akwa Ibom State, Nigeria.

2.2. Experimental Design

This study adopts a comparative experimental design to evaluate the microbial content and flavor profile of sour soups made with *Gnetum africanum* and *Cucurbita pepo* leaves.

2.3. Sample Collection

Samples were bought in Ikono main market. The items bought are 20grams of *Gnetum africanum* leaves (Afang), 20grams of *Curcubita pepo* leaves (vegetable), 20grams of meat, 10grams of crayfish, 15 grams of water leaves, 5grams of pepper, 5grams of salt, 20grams of fish, 5grams of maggi cube and 5grams of periwinkles. Other Laboratory Materials/ utensils used for the experiment includes: Weighing balance, Microscope, stainless pot, spoon, plates, incubator, and culture media.

2.4. Soup Preparations

Two steel pots and one stainless spoon were used. Electric cooker was used for the cooking. All the equipment used were sterilized. Afang was washed and sliced. And it was pounded in a mortar using pestle, likewise crayfish and pepper. The cow meat was washed and cut into pieces before steaming. The steaming temperature was 39°C. The process was repeated for fish. 2000 ml of water was put in the stainless pot and all the prepared condiments were added at required interval and were boiled for 45minutes in the electric gas. The same process was carried on the preparation of vegetable soup. The two pot of soup were kept in at constant room temperature for three days. All the samples were properly labeled.

2.5. Determination of pH:

pH meter was used to measure hydrogen ion activity (acidity or alkalinity) in solution. pH meter consist of a voltmeter attached to pH responsive electrode and a reference (unvarying) electrode. The P^H- responsive electrode is usually glass and the reference is usually silver. The two electrode was immersed in the 20ml (sour soup) acted as a battery. The glass electrode developed an electric potential (charge) that was directly related to the hydrogen ion-activity in the solution. The voltmeter measure the potential difference between the glass and reference electrode and the different was observed and recorded (Skoog *et al.*, 2014).

2.6. Determination of Titratable Acidity (TTA)

Titratable acidity is a total amount of acid in the solution as determined by the acid in the solution as determined by the titration using a standard solution of sodium hydroxide (titrant). The reaction completion is determined by a

chemical indicator that changes its colour at this point. The acid content of the sour soup was determined by titrating 20ml samples with a base (0.1g NOAH). Phenolphthalein was used as indicator. The result was recorded (Harris, 2015).

2.7. Determination of flavour profile

Chemical Analysis: Gas Chromatography-Mass Spectrometry (GC-MS) will be employed to identify and quantify the volatile flavor compounds in the soups. Sensory Evaluation: A trained sensory panel will evaluate the soups based on attributes such as sourness, bitterness, astringency, and overall flavor balance using a structured sensory evaluation form (Stone and Sidel 2004).

The volatile compounds in the sour soup samples were analyzed using Gas chromatograph- Mass Spectrometry (GC-MS). 0.30grammes of soup was accurately weighed and put into a 20ml headspace (HS) vial with a magnetic screw seal cover. Then the samples were incubated at 50°C for 10 mins. After incubation, 100ml of the headspace sample were automatically injected into tube through a heated syringe at 65°C the column was kept at 60°C with the drift tube temperature at 45°C. The drift gas flow was cut to a constant flow rate of 150ml/min. Nitrogen carrier gas was used- following the suggestions of Liu *et al.*, (2023). The retention index (RI) of volatile compounds was identified by comparing their Retention Index (RI) and ions drift time. Each sample was detected. The quantification of volatiles compounds was based on the peak signal intensity.

2.8. Isolation and Identifications of Bacteria

Microbial Enumeration: Total viable counts were conducted for aerobic bacteria, lactic acid bacteria, yeast, molds, and potential pathogens such as *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella* spp. Microbial Identification: Selective media and biochemical tests were used to identify the microbial species present in the soups.

Bacterial isolation was performed using nutrient agar 2.8g/100ml, MacConkey agar 5.2g/100ml, and Dextrocholate citrate agar 4.3g/100ml respectively. All the media used in the present study were prepared according to the manufacturer's specification and collected samples were inoculated into plates and incubated at 37°C for 24 to 48 hours (Angelini *et al.*, 2022).

Colonies identified as discrete on nutrient agar were carefully examined microscopically (using stereo microscope) for cultural characteristics such as the shape, colour, size and consistency. Gram staining as well as appropriate biochemical tests was carried out according to the standard procedure (Calvo *et al.*, 2019). The isolates were identified by comparing their morphological and biochemical characteristics with standard reference organisms of known taxa as describe in Berge's Manual for Determinative Bacteriology (Bota and Harrington, 2020).

2.9. Statistical Analysis:

The data from microbial counts and sensory evaluation was analyzed using statistical methods, including ANOVA, to determine significant differences between the soups. Overall bacterial load was calculated using descriptive statistic the sample through frequencies and cross tabulations. Post-hoc tests were applied as necessary to compare means.

3.0. RESULTS AND DISCUSSION

The study yielded a range of results in the areas of microbial analysis, chemical composition, sensory evaluation, and consumer acceptability. These results provide insights into both the safety and the sensory characteristics of the sour soups prepared with *Gnetum africanum* and *Cucurbita pepo* leaves.

Table 1: Microbial Counts (CFU/mL) in Sour Soups Prepared with Leaves from *Gnetum africanum* and *Cucurbita Pepo*

Microbial Group	Sour Soup with <i>Gnetum africanum</i>	Sour Soup with <i>Cucurbita pepo</i>
Total Aerobic Bacteria	3.2×10^4	2.9×10^4
Lactic Acid Bacteria	2.5×10^4	2.1×10^4
Yeast and Molds	1.0×10^4	1.3×10^4
<i>Escherichia coli</i>	Absent	Absent
<i>Staphylococcus aureus</i>	1.6×10^2	1.1×10^2
<i>Salmonella spp.</i>	Absent	Absent

Data showing mean of 3 replicate determination \pm standard deviation
CFU/mL: Colony- Forming Units per milliliter.

The microbial counts were within acceptable limits for both soups, with slightly higher counts observed in the *Gnetum africanum* soup. Both soups were free from pathogens like *Escherichia coli* and *Salmonella*, indicating good microbial safety. The presence of lactic acid bacteria and yeasts suggests some level of fermentation, which is typical for sour soups and contributes to their flavor.

Table 2: Chemical Composition of Sour Soups (per 100g) Prepared with Leaves from *Gnetum africanum* and *Cucurbita Pepo*

Component	Sour Soup with <i>Gnetum africanum</i>	Sour Soup with <i>Cucurbita pepo</i>
pH	4.10 ± 0.01	4.30 ± 0.01
Titrateable Acidity (%)	0.85 ± 0.01	0.75 ± 0.00
Moisture Content (%)	87.20 ± 1.20	86.80 ± 1.20
Ash Content (%)	1.20 ± 0.01	1.00 ± 0.00
Protein Content (%)	2.30 ± 0.02	2.10 ± 0.00
Fat Content (%)	0.50 ± 0.00	0.40 ± 0.00
Carbohydrate Content (%)	8.80 ± 0.12	9.00 ± 0.01
Total Polyphenols (mg GAE/g)	45.20 ± 0.12	38.50 ± 0.12

Data showing mean of 3 replicate determination \pm standard deviation
mg GAE/g: Milligrams of Gallic Acid Equivalents per gram

Both soups exhibited similar chemical compositions, with slight differences in titrateable acidity and polyphenol content. The higher polyphenol content in the *Gnetum africanum* soup might contribute to its more complex flavor profile and higher antioxidant potential. The pH and titrateable acidity levels indicate that both soups have the sourness expected from such traditional dishes.

Table 3: Sensory Evaluation Scores Prepared with Leaves from *Gnetum africanum* and *Cucurbita Pepo*

Sensory Attribute	Sour Soup with <i>Gnetum africanum</i>	Sour Soup with <i>Cucurbita pepo</i>
Sourness	7.40 ± 0.01	6.60 ± 0.01
Bitterness	5.50 ± 0.01	4.20 ± 0.00
Astringency	6.70 ± 0.02	4.50 ± 0.00
Umami	7.20 ± 0.03	6.90 ± 0.02
Aroma	8.00 ± 0.20	7.50 ± 0.21
Overall Flavor Balance	8.20 ± 0.10	7.40 ± 0.21
Mouthfeel	7.50 ± 0.10	7.00 ± 0.00

Appearance	7.80 ± 0.20	7.30 ± 0.01
Consumer Acceptability	7.90 ± 0.03	7.10 ± 0.02

Data showing mean of 3 replicate determination ± standard deviation

GC-MS – Gas Chromatograph- Mass Spectrometry

PPM – Part Per Milion

The sensory evaluation scores suggest that the soup with *Gnetum africanum* had a stronger and more balanced flavor profile, with higher scores for sourness, astringency, and overall flavor balance. The higher consumer acceptability score for *Gnetum africanum* soup indicates a preference for its distinct taste, which could be attributed to its unique combination of flavors.

Table 4: Volatile Compounds Identified by GC-MS in Sour Soups Prepared with Leaves from *Gnetum africanum* and *Cucurbita Pepo*

Volatile Compound	Sour Soup with <i>Gnetum africanum</i> (ppm)	Sour Soup with <i>Cucurbita pepo</i> (ppm)
Acetic Acid	1.25 ± 0.00	1.10 ± 0.00
Hexanal	0.85 ± 0.00	0.90 ± 0.01
Phenylacetaldehyde	0.95 ± 0.00	0.65 ± 0.00
2,3-Butanedione	1.15 ± 0.01	1.20 ± 0.01
Linalool	0.45 ± 0.01	0.50 ± 0.01
Eugenol	0.65 ± 0.00	0.35 ± 0.01
Isobutyl acetate	0.50 ± 0.1	0.30 ± 0.00
β-Caryophyllene	0.70 ± 0.00	0.40 ± 0.00

Data showing mean of 3 replicate determination ± standard deviation

PPM: Part-Per-Million

The GC-MS analysis identified a range of volatile compounds that contribute to the aroma and flavor of the soups. The *Gnetum africanum* soup had higher levels of certain compounds like phenylacetaldehyde and eugenol, which are known for their strong and pleasant aromas. The differences in volatile compound profiles between the two soups suggest that *Gnetum africanum* leaves impart a more complex and aromatic flavor compared to *Cucurbita pepo* leaves.

4.0. DISCUSSION

The findings of this study indicate significant differences in the microbial content, chemical composition, and sensory characteristics of sour soups prepared with *Gnetum africanum* and *Cucurbita pepo* leaves (Okafor, 1990 and El-Adawy *et al.*, 2014).

The microbial counts for both soups were within acceptable limits, indicating that these traditional dishes are safe for consumption. The slightly higher microbial counts observed in the *Gnetum africanum* soup could be attributed to the inherent microbial flora associated with this leaf, which might influence the fermentation process and contribute to the soup's unique flavor profile. The absence of pathogens such as *Escherichia coli* and *Salmonella* in both soups is a positive outcome, affirming the safety of the preparation methods used in this study (Angelini, *et al.*, 2022 and Calvo, *et al.*, 2019).

The chemical analysis revealed that the *Gnetum africanum* soup had a higher titratable acidity and polyphenol content compared to the *Cucurbita pepo* soup. Higher acidity levels contribute to the sour taste, which is a characteristic feature of these traditional soups. The elevated polyphenol content in *Gnetum africanum* may

explain the soup's more complex flavor profile and potential antioxidant benefits, aligning with findings from previous studies on the nutritional and functional properties of *Gnetum africanum* leaves (Okafor, 2019).

The sensory evaluation scores demonstrated a preference for the soup made with *Gnetum africanum* across several attributes, including sourness, bitterness, astringency, and overall flavor balance. This suggests that *Gnetum africanum* contributes more intense and complex flavors to the soup, which are generally well-received by consumers. The higher scores for bitterness and astringency in the *Gnetum africanum* soup could be related to its higher polyphenol content, as polyphenols are known to impart these sensory characteristics (Ezeama, 2021 and Book & Fromm H. 2018).

The GC-MS analysis revealed a richer profile of volatile compounds in the *Gnetum africanum* soup, including higher concentrations of phenylacetaldehyde, eugenol, and β -caryophyllene. These compounds are associated with pleasant aromas and flavor complexity, which likely contribute to the higher sensory evaluation scores for aroma and overall flavor balance observed in this study. The distinct volatile profiles underscore the potential of *Gnetum africanum* as a key ingredient in traditional dishes that require a strong and aromatic flavor profile (Lui, *et al.*, 2023).

5.0. RECOMMENDATIONS

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

- (i) Further research should be embarked upon to investigate the nutritional composition and potential health benefits of these sour soups.
- (ii) In terms of Product development the potentials for commercialization of these sour soups, should be explore, considering different flavour variations and packaging options.
- (iii) Consumer education: should be advocated to promote the use of *Gnetum africanum* and *Curcubita pepo* leaves as ingredients for healthy and flavourful soups.
- (iv) In terms of sustainability: cultivation and harvesting of this leaves (*Gnetum africanum* and *Curcubita pepo* leaves) should be encourage to ensure their long-term availability.
- (v) Food safety advocacy should be emphasized in order to promote the importance of proper hygiene practices during the preparation and storage of these soups to maintain microbial safety.

6.0. CONCLUSION

After careful study, analysis and observation, the following conclusion could be drawn from the research

- (i) It was observed that the sour taste was caused by three major Lactic acid micro-organism, namely; *Brochothrix thomosphacta*, *Lactobacillus* and *Pediococcus*.
- (ii) This study revealed that sour soup are not harmful to humans but the noxious smells are produced by microbes to repulse large animals, thereby keeping the food resources for themselves.
- (iii) The study successfully evaluated the microbial quality and flavour profile of sour soups prepared using leaves from *Gnetum africanum* and *Curcubita pepo*.
- (iv) The results indicated that both leaf sources can be used to produce safe and flavourful sour soups.
- (v) The microbial load in the soups was within acceptable limits, suggesting good hygiene practices during preparation.
- (vi) The flavour profiles of the soups were distinct, highlighting the unique characteristics of each leaf source.
- (vii) This study highlights the safety, flavor profile, and consumer acceptability of sour soups prepared with *Gnetum africanum* and *Cucurbita pepo* leaves.
- (viii) The findings suggest that *Gnetum africanum* may offer a more robust and appealing flavor for traditional sour soups, while both soups meet acceptable microbial safety standards.

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Openness, Competitiveness and Human Capital Development in Nigeria

***¹Udo, S. S. & ²Udo, E. G.**

^{*1&2}Department of Economics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa
Ibom State, Nigeria

*Corresponding Author Email: sasedo2016@gmail.com, Tel: +2348025919259

Abstract

The study examined the effect of openness on the competitiveness level in Nigeria and how both openness and competitiveness have affected human capital development in the country. The study adopted the classical linear regression and thus used Autoregressive Distributed Lag technique. The data were sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin 2021 and World Development Indicators. Openness, Ease of Doing Business (EODB), Foreign Direct Investment (FDI), imports on capital goods and Government Efficiency (GOVEFF) from 1980 to 2022. Some of the data were sourced from World Development Indicator were some of the variables used in the study. The results showed that openness had a positive and significant effect on Nigeria competitiveness and thus on human capital development. The result described a number of drivers for Nigerian openness, and competitiveness. Based on these results, the study recommended that the government implement policies to ensure that companies flourish in a conducive setting. In Nigeria, in particular, a seamless business registration process should be created. This study suggests other steps that the government should put in place to open up the economy and thus make Nigeria more competitive in an increasingly global market which are credit facilities, tax incentives, and infrastructure provision, pursue consistent and well-targeted monetary policies by monetary authorities in order to stabilize the price of the domestic currency (the naira), and curb inflation.

Keywords: Openness, Human, Capital, Development, Competitiveness, Efficiency

1.0. INTRODUCTION

Opening up the economy has been an important factor for the competitiveness and hence human capital development of countries in Africa, Europe, Asia and some other parts of the world. It is indeed of great importance to Sub-Saharan African nations where most of them are developing economies that aim at competing with other developed countries so as to achieve sustainable economic development (Nnadi, 2020). According to Ogohi, (2019), nations that open their economies and coordinate their economic policies, liberalize trade and move capital across borders are more likely to accrue benefits that are not possible otherwise. For instance, literatures revealed that openness has enhanced global communication, interaction and exchange of ideas among people of different nationalities and background. openness transcends all spheres of life including the educational sector, as scholarly ideas are made available to those in search of knowledge. It has also helped in increasing capital deepening, employment opportunities and the rate of development. It increases business chances, innovation, technology and social affiliation. Openness leads to growing inter-dependence and interconnectedness of modern world. Developed countries integrate with developing countries by means of reducing trade barriers and increasing foreign direct investment and in many cases increase cross border migration. Many developed countries have witnessed competitiveness and thus human capital development as a result of openness (Nyong, 2015).

Competitiveness is seen as the set of institutions, policies and factors that determine level of productivity of a country (World Economic Forum, 2021). Dunning (1992) sees competitiveness as the ability to sustain in a global economy, any acceptable growth in the real standard of living of the population with an acceptable fair distribution,

while efficiently providing employment for substantially all who can and wish to work and doing so without reducing the growth potential in the standards of living of future generation. Economic competitiveness is thus a goal to be pursued by developing countries (Ntoiden & Udo 2015).

One of the major objectives of developing economies is how to stimulate the rate of international competitiveness and hence improve human development and no country can develop its citizens in isolation thus the need to open up the economy and competition with other countries of the world is vital and at most time to achieve that, trade and inflow of foreign direct investment must be enhanced. Theories and literatures have argued for the nexus between trade openness, competitiveness and human capital development. This is to say for human development to occur in any country the economy must be opened, and open economy encourages development of the nation, where goods and services are allowed to move freely across nations. In the case of Nigeria, different and past administrations have adopted numerous approaches and policies to encourage trade openness aimed at encouraging competitiveness and thus human capital development at the end. Sequel to the above, Nigeria joined the World Trade Organization (WTO) in 1983. This was done to improve the level of trade openness, improved productivity and thus compete favourably with other countries of the world and by so doing become a competitor in the global market with major aim of improving the rate at which human capital can be developed. Failing to produce the desired results, Nigeria decided to introduce the Structural Adjustment Programme (SAP) that was suggested to them by International Monetary Fund (IMF) in 1986 during Babangida's administration. The suggested one-sided policy of the IMF with its attendants' problems failed to yield the desired results. Again, the quest for further improvement in the economy led to Nigeria's adoption to many other policies to encourage trade openness, competitiveness and human capital development. Studies have revealed that, the macroeconomic policy of Nigeria since 1986 is guided by this neoliberal philosophy. Even the Economic Recovery and Growth Plan (ERGP) of the Buhari Administration was underpinned by the same neoclassical ideology. Tinubu's administration is not left out of policies to encourage openness and competitiveness with central aim of improving the rate of human capital development. This is one of the reasons the administration introduced the market money and small industrial palliative money to aid the small and medium scale industries mostly during fuel subsidy removal. To ensure openness, competitiveness, accelerated growth and human development, the policies by Tinubu's administration underscores the imperative of openness by encouraging firms to invest in Nigeria.

Tinubu inherited a [sputtering](#) Nigerian economy, with gross domestic product (GDP) growth rates for 2022 at 3.1% and for the first quarter of 2023 at 2.31%. Nigeria's recovery from COVID-19-induced trade deficits has also been slow. The 2022 trade surplus at only \$2.85 billion pales in comparison to 2014's \$54.1 billion. Foreign direct investment into Nigeria's economy fell from \$2.2 billion in 2014 to \$0.47 billion in 2022. The budget deficit has [risen](#) by 370.54% from 2016 to 2023, and the cost of debt servicing has exceeded public revenues as public debt has grown tenfold in a decade. Total public debt as of June 2013 was N7.93 trillion. It's now at around N77 trillion. During this period, external debt grew by 473% and domestic debt by 7 029%. The Central Bank of Nigeria's (CBN) lending to the federal government saw high inflation rates moved to [22.41%](#) by May 2023. These pressures, as well as [insecurity](#), have contributed to higher food prices, while 63% of the country live in multidimensional poverty. The unemployment rate was 33.3% in 2020 and [estimates](#) this to climb to 40.6% 2024, (CBN2023). Tinubu is also putting policy in place by floating the naira. Between 2019 and 2024, the official exchange rate from naira to dollars was mostly fixed, rather than determined by market forces. Because of this trend the CBN however couldn't meet the demand for dollars at this rate, contributing to a thriving forex black market and dampening of investors' confidence. The Tinibus's administration has directed banks to 'trade the naira freely' at rates determined by demand and supply. This policy by this current administration is to [free](#) up the resources the CBN used to 'defend' the naira, reduce the budget deficit, and attract more foreign investment which is aimed at improving the rate of human capital development, (Udo, 2023). The administration also targeted opening the economy by boosting Nigeria's productivity, productive capacity and growing and diversifying its exports away from crude oil into agrarian economy by expanding the anchor borrower scheme of the federal government for farmers. The administration policy via the CBN also removed ban on selected items imported to Nigeria to open up the economy.

Also, taking for instance policies within the ERGP framework that was aimed at strengthening Nigeria's bilateral and multilateral economic relations with other countries of the world was to enhance openness and competitiveness and thus improve indicator of human development in Nigeria. The signing of the currency swap deal with the People's Republic of China underscores the need to grow a competitive economy in a world of increasing openness. The main aim of these policies was to make the economy investor friendly by enhancing the ease of doing business where our exchange rate shall be favourable to both Nigerians and the Government of Nigeria.

Having adopted these policies and programmes, the question then arises, what is the position of Nigeria in the world in term of competitiveness and human capital development?

One wonders if openness has contributed to economic competitiveness, productivity of the Nigerian economy and human capital development. The policy thrust of the government which has consistently maintained years of openness since 1986 should have positively impacted on the economy's competitiveness and thus develop human capital. But has it? This study therefore undertakes to investigate the impact of openness on competitiveness on the one hand as well as their separate impact on human capital development.

This study is different from other studies because it does not only limit itself to trade but it considers the impact of openness on Human capital development This forms the basis on which impact of openness on the competitiveness and human capital development in the Nigerian economy would be assessed. This will enable the study analyze how openness impacts significantly on the competitiveness and human development index of the Nigerian economy. Specifically, the study attempts to answer the following questions:

- (i) What is the impact of openness on economic competitiveness in Nigeria?
- (ii) What is the effect of openness and competitiveness on human development index in Nigeria?

1.1. Objectives of the study:

The broad objective of the study is to determine the impact of openness on competitiveness and hence on human development index in Nigeria. The specific objectives are to:

- (i) Evaluate the impact of openness on competitiveness in Nigeria.
- (ii) Examine the effect of openness and competitiveness on human development index in Nigeria.

1.2. Research hypotheses

To achieve the above objectives, the following hypotheses were formulated to guide the study. They are tested in null form:

- (i) Ho: There is no significant impact of openness on competitiveness in Nigeria.
- (ii) Ho: There is no significant impact of openness and competitiveness on human development index in Nigeria.

1.3. Institutional Perspective Theory of Competitiveness

This theory was initiated in 1982 by Panzer and Rosse. The theory is commonly called Panzar-Rosse Hypothesis. This came in the heels of intense global drive for institutional adjustment to check the level of development of economies. The theory argued that better institutions enhance quality and highly educated citizens which will embrace peace and understands the needs of opening up the economy. According to the theory openness will increase the level of productivity, which in turn, sets sustainable level of competitiveness. In other words, more-competitive economies tend to be able to produce higher levels of income for their citizens. The level of productivity also determines the rates of return obtained by investments in that country. This is because the rates of return are the fundamental drivers of the growth rates of the economy; a more-competitive economy is one that is likely to grow faster in the medium and long run. This theory is a modification of the classical theory of competitiveness by Adam Smith which focuses on specialization and division of labour. To the institutional perspective theory, emphasis is on investment on physical and human capital and infrastructure and, more recently, to interest in other mechanisms such as education and training, technological progress (whether created within the country or adopted from abroad),

macroeconomic stability, good governance, the rule of law, transparent and well-functioning institutions, firm sophistication, demand conditions, market size, and many others. They further opined that competitiveness is the umbrella goal for different areas of integration and convergence of what generally can be called business sophistication. Under the competitiveness umbrella, according to them, the policies that address the internal market, industry, research and innovation and space are interweaved and follow a common vision of growth of human and physical capital.

1.4. Empirical literature

This section reviews empirical works of other scholars and peer reviewed on openness and competitiveness, and on competitiveness and human capital development in Nigeria and abroad. The first section of this subsection focuses on studies conducted in other economies while the second subsection reviews studies done in Nigeria.

Yalçinkaya, Çılbant, Yalçinkaya and Güneş (2020) in their study examined how openness has affected the level of competitiveness of industrialised countries of the world. The research work adopted descriptive statistics in the investigation. They opined that the competition for countries can only be a type of incorporation. A country's competitiveness depends according to the study on factors such as the level of sophistication and productivity of research and development activities, performance of the various sectors, country's foreign trade surplus, production of goods that have high-tech characteristics, and availability of skilled and experienced manpower. They advocate that the competitiveness of a national economy is a macro-economic phenomenon, so it is determined by factors such as interest rates, exchange rates, and budget deficits. Similarly, some economists advocate that the competitiveness can be achieved with cheap and abundant labour force. The study discusses entrepreneurs' problems in enhancing the competitiveness, which becomes more important because of globalization, and precautions to be taken to reduce or completely eradicate these problems, at micro- and macro-economic levels.

Barney (2019) carried out a study investigating the contributions of openness on the level of competitiveness and on human capital formation in the United State of America. The study used secondary data in analysing the work and the method of study adopted was descriptive statistics. The study used panel data for a period of twenty years in analysing the study. The data were collected through questionnaire from different firms in the country. The result of the study showed that sustainable competitive advantage is attained when a firm has a human resource pool that cannot be imitated or substituted by its rival. The study further revealed that one of the major reasons human capital continue to hold the attention of economic and organizational strategists is that, the human capital will continue to be the comparative advantage of the future. The work also revealed that for competitiveness to be effective countries need other countries to compete with. This means opening up economies will lead to competition. The study therefore recommended that the American government should invest more on the education sector mostly on the tertiary education level. The study further recommended that private firms should partner with the American government to train human resource through staff development programmes. The researcher also recommended that the American government should open their economy to enable other countries exchange ideas, technology, goods and services with them.

Nwakanma and Ibe (2020) evaluated the causal relationship between openness and economic development in Nigeria from 1981 to 2020. They used time series data from the CBN Statistical Bulletin and Annual reports to conduct the study. Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) unit root tests were carried out to test for the stationarity of the variables. The data were found to be integrated of order I (1). They proxied Gross Domestic Product (GDP) to measure economic growth while financial integration, human resource development (HRD) and trade openness (OPEN) were proxied to measure openness. The cointegration result showed the existence of a long run equilibrium relationship. By the above results they decided to adopt error correction mechanism technique. The results of the work revealed a positive and insignificant relationship between financial integration, human resource development and trade openness while gross fixed capital formation was negative and insignificant. The used of granger causality test revealed a unidirectional causal relationship between financial integration and gross fixed capital formation. Furthermore, there was also a unidirectional causality between trade

openness and gross fixed capital formation. The result showed that the insignificant relationship could be as a result of insufficient capital inflow into the economy and so many negative factors available the Nigerian economy.

Konyeaso (2021) investigate the kind of impact openness is having on Nigerian economy. The study used time series data from 1986 to 2021 adopted from Central Bank Nigeria (CBN). Konyeaso in the study used Ordinary Least Square (OLS)-multiple regression analysis to find out the impact of openness on economic development in developing countries in general and Nigeria in particular. The choice of the OLS as a method of analysis was derived from the fact that the results of the Augment Dickey Fuller (ADF) unit root test showed that variables were all cointegrated at levels. The result of the findings showed that openness and economic development were positively related, that is, there is a positive relationship between openness and economic development in Nigeria. The study specifically opined that Nigerian economy is gaining from openness because of Foreign Direct Investment (FDI). The study then recommended that government and corporate organisations should encourage foreign direct investment and also do everything possible to open up the economy. They also recommended provision of peaceful business environment that will make more investors to come into operating in Nigeria.

Adeleke (2021) adopted the Augmented Dickey Fuller (ADF) to find out if the data used in the study were stationary and if so at what levels were they integrated. This led to the choice of the Ordinary Least Square method for the analysis. The study used Granger Causality test to investigate the direction of causation between openness and economic development of Nigeria. The study used secondary data obtained from Central Bank of Nigeria (CBN) Annual Report and Statement of Account, the CBN statistical bulletin from 1980 – 2021 and some of the data were collected from the world bank data tables. In the study the finding revealed that foreign direct investment proxied as openness positively affected economic development of Nigeria. The result further revealed that the causality test had a unidirectional causality existing between economic development and openness. What this means is that causality flows from openness to economic development in Nigeria. The study showed that state of economic development influences how Nigeria can benefit from openness. The study recommended that every machinery should be put in place by the government to enhance openness in Nigeria (Udo, et al., 2022).

2.0. RESEARCH METHODOLOGY

2.1. Research Design

The study employs an econometric methodology to investigate the impact of openness on competitiveness and human capital development in Nigeria. The study adopts an ex post facto (after the fact) design. This is because the events had already taken place before the investigation is carried out. The choice of this design is made because the researcher has no control of the independent variables, and inferences about the relationship among the variables are made without the current interaction among the regressand and regressors (Porter, 1990).

2.2. Model specification

Following the theories and the empirical literature reviewed, the study therefore specifies two equations. The first is the competitiveness equations which identify variables that affect competitiveness and second equations is the human capital development equation. The first equation which proxied by ease of doing business explains how internal influence affects competitiveness. The second equation is the human development index equation which explains the variables that influence human capital development.

2.3. Competitiveness Equation

There are many measures used in measuring competitiveness but Competitiveness in this study is measured by ease of doing business (EODB). The choice of using ease of doing business is because EODB considers the effect of domestic and foreign factors on the level of competitiveness in Nigeria.

The ease of doing business equation is rooted in the institutional perspective theory while human development index equation is rooted in the Porter theory. The porter theory opined that through openness new ideas are diffused from one country to another in form of technology to human who will use the technology to develop themselves and the technology in this study is measured by imports on capital goods. The improved technology will lead to a high degree of productivity and hence increased level of competitiveness. Institutional perspective theory

states that government effectiveness adopted in this study as quality of institutions provide framework for openness to thrive in the short run and this translates into competitiveness in the long run. (Barney, 2016)

$$EODB = f(OPEN, NFDI, IMCAPG, GOVEFF,) \quad (3.1)$$

The econometric form of equation (3.1) can be written as:

$$EODB = \omega_0 + \omega_1 OPEN + \omega_2 NFDI + \omega_3 IMCAPG + \omega_4 GOVEFF + V_1 \quad (3.2)$$

Where;

EODB = Ease of doing business Index

OPEN = Openness

NFDI = Net Foreign direct investment

IMCAPG = Importation on Capital Goods for level of Technology

GOVEFF = Government Effectiveness for Institutional quality index

V_1 = Error terms

$\omega_1, \omega_2 \dots \omega_4$ are the coefficients to be estimated.

The a priori expectation is that $\omega_1 > 0; \omega_2 > 0, \omega_3 > 0; \omega_4 > 0$.

$$HDI = f(EODB, RER, GDI, INFL, OPEN) \quad (3.3)$$

Equation (3.3) can be rewritten as:

$$HDI = \lambda_0 + \lambda_1 EODB + \lambda_2 RER + \lambda_3 GDI + \lambda_4 INFL + \lambda_5 OPEN + V_3 \quad (3.4)$$

Where:

EODB = Ease of doing business Index

OPEN = Openness

HDI = Human development index

RER = Real Exchange rate

GDI = Gross domestic investment

INFL = Inflation rate

V_3 = Error terms

$\lambda_1, \lambda_2 \dots \lambda_5$ are the coefficients to be estimated.

The a priori expectation is that $\lambda_1 > 0; \lambda_2 < 0, \lambda_3 > 0, \lambda_4 < 0, \lambda_5 > 0$.

3.0. METHODS OF ESTIMATION

This study employed unit root tests, co-integration technique, Granger causality test, and Auto regressive distributive lag (ARDL) technique to estimate the specified equations. The ARDL method of estimation has many advantages over other methods and some of the merits are; in case of small sample size, ARDL modeling approach is more robust in performing better to verify identity cointegrating variables, while a method like that of Johansen cointegration, require larger sample to achieve reliability. Secondly, it does not involve pre testing variables. Finally, if the researcher is not sure of the value of calculated unit of the stationarity test, the cointegrating

I(1) or I(0) is applied manually which make ARDL technique best suitable for research. This means if the type of the stationarity of the data is not clear, the use of the ARDL Bounds test is suitable. (Pesaran et al., 2001).

The Bounds test of co-integration approach was used because it helps to determine if there exist any long run relationship between the variables and hence accurate prediction was confidently made on the economic relationship between the variables.

3.1. Unit Root Test

Since this study is using time series data a unit root test is adopted to detect the stationarity of the data. This test help in avoiding spurious results in the study. Base on this, we employ Augmented Dickey-Fuller (ADF) test for the stationarity test of the time series data. To use the ADF method, the equations to use in testing the data are:

$$\Delta y_t = \alpha_0 + \alpha_1 \Delta y_{t-1} + \sum_{j=1}^j \beta_j \Delta y_{t-j} + \varepsilon_t \quad (3.5)$$

Where:

$\Delta y_t = y_t - y_{t-1}$ is the difference of series y_t

$\Delta y_{t-1} = y_{t-1} - \Delta y_{t-2}$ is the difference of y_{t-1}

ε_t = stochastic error term

α_0, α_1 and β_1 are the parameters to be estimated.

Decision rule:

If $\alpha_1 = 0$ the null hypothesis of the non- stationary is accepted

But if $\alpha_1 < 0$ and statistically significant, then the null hypothesis is rejected

3.2. ARDL Cointegration Test

The general form of the ARDL of the specified equations are:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \dots + \beta_k Y_{t-p} + \alpha_0 X_t + \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \dots + \alpha_q X_{t-q} + \varepsilon_t, \quad (3.6)$$

From the general model in equation (3.6), the ARDL models for the study can be modified to suit our analysis thus;

$$\begin{aligned} \Delta EODB_t = & \omega_0 + \omega_1 EODB_{t-1} + \omega_2 GLOB_{t-1} + \omega_3 NFDI_{t-1} + \omega_4 IMCAPG_{t-1} + \omega_5 DGOVEFF_{t-1} \\ & + \sum_{i=0}^k \lambda_1 \Delta EODB_{t-1} + \sum_{i=0}^k \lambda_2 \Delta \ln GLOB_{t-1} + \sum_{i=0}^k \lambda_3 \Delta NFDI_{t-1} + \sum_{i=0}^k \lambda_4 \Delta IMCAPG_{t-1} \\ & + \sum_{i=0}^k \lambda_5 \Delta DGOVEFF_{t-1} + \mu \quad (3.7) \end{aligned}$$

$$\begin{aligned} \Delta_t HDI = & \lambda_0 + \lambda_1 HDI_{t-1} + \lambda_2 EODB_{t-1} + \lambda_3 RER_{t-1} + \lambda_4 GDI_{t-1} + \lambda_5 INFL_{t-1} + \lambda_6 GLOB_{t-1} \sum_{i=0}^k \lambda_1 \Delta HDI_{t-1} \\ & + \sum_{i=0}^k \lambda_2 \Delta EODB_{t-1} + \sum_{i=0}^k \lambda_3 \Delta RER_{t-1} + \sum_{i=0}^k \lambda_4 \Delta GDI_{t-1} + \sum_{i=0}^k \lambda_5 \Delta INFL_{t-1} \\ & + \sum_{i=0}^k \lambda_6 \Delta GLOB_{t-1} \quad (3.8) \end{aligned}$$

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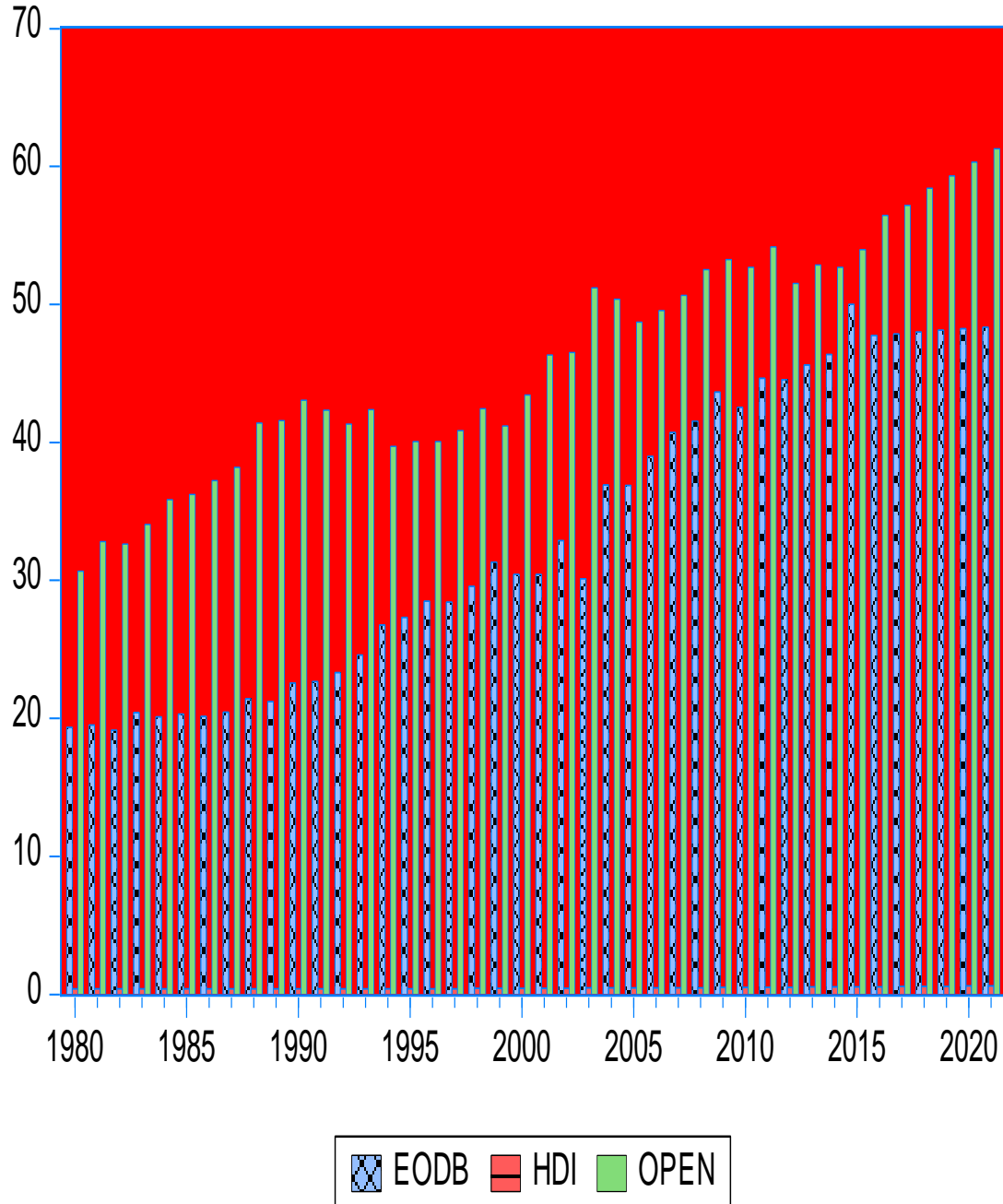


Figure 1: Openness, Ease of Doing Business (EODB) and Human Development (HDI) in Nigeria

Source: Author's compilation, (2024)

The trend showing in figure 1 above is extracted from raw data collected from CBN Statistical Bulletin and World Economic Forum Bulletin. The question had been, is openness enhancing competitiveness and hence human capital development? From figure 1 it has been observed that openness throughout the period under investigation lies above competitiveness index and human capital development proxied by human development index. This means openness may be the one affecting competitiveness and also it may be that competitiveness is also affecting human capital development as opined by many literatures though with insignificant effect. Then if what we are suspecting (openness is affecting competitiveness very little and hence human capital development) is right, then could it be the approach of the government to the policies of enhancing openness is poor? Looking at the trend in figure 1 it may be government is focusing mostly on other policies to enhance openness and living the development of human capital. This may be the reason human capital development index (HDI) is lying so close to the origin and appear insignificant in the graph.

4.0. PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

This section presents the empirical result, analysis as well as the discussion of findings. Specifically, it discusses the unit root tests, cointegration test, , and autoregressive distributed lag tests.

4.1. Result for Unit Roots Test

The Augmented Dickey-Fuller (ADF) is employed to test for the stationarity of each variable. The null hypothesis is that the variable under investigation has a unit root, and therefore is non-stationary. The result from the test shows that some variables are integrated at order zero $\sim I(0)$ while others are at first difference $\sim I(1)$. Inflation (INFL), net foreign direct investment and government effectiveness are stationary at levels. This means that other variables have unit root according to the test criteria. Therefore, these non-stationary variables are differenced once to attain stationarity. The results are presented in table 3.1 below:

Table 1: Unit Root test using Augmented Dickey-Fuller (ADF)

Variable	ADF Statistic (Level form)	Critical values		ADF Statistic (1st Diff.)	Critical values		Order of Integration Decision
		1%	5%		1%	5%	
EODB	0.549498	-3.621023	-2.94	-10.06959	-3.621023	-2.9434	I(1)
GDI	-0.134883	-3.615588	-2.941145	-4.962368	-3.689194	-2.971853	I(1)
OPEN	-0.840177	-3.615588	-2.941145	-6.949132	-3.621023	-2.943427	I(1)
GOVEFF	-3.959857	-3.615588	-2.941145				I(0)
HDI	1.022869	-4.219126	-3.533083	-6.887409	-4.226815	-3.536601	I(1)
IMCAPG	-1.790370	-4.219126	-3.533083	-4.773377	-4.226815	-3.536601	I(1)
INFL	-3.664187	-4.226815	-3.536601				I(0)
NFDI	-3.387799	-3.615588	-2.941145				I(0)
RER	-1.741851	-4.219126	-3.533083	-4.691835	-4.226815	-3.536601	I(1)
RGDP	-1.699657	-4.219126	-3.533083	-5.152143	-4.226815	-3.536601	I(1)
SPREAD	-2.831027	-4.219126	-3.533083	-6.504432	-4.234972	-3.540328	I(1)

Source: Computed by Author, 2024

The result of the unit root test as shown in table 3.1 indicates that net foreign direct investment, inflation and government effectiveness are all stationary at levels and thus we reject the null hypothesis which state that there

is no unit root at levels. This means the three variables have no unit root at levels. The other variables- ease of doing business (EODB), gross domestic investment (GDI), openness (OPEN), human development index (HDI), import on capital goods (IMCAPG), real exchange rate (RER), real gross domestic product (RGDP) and interest rate (SPREAD)- achieved stationarity upon first differencing. The mixed order of integration of the variables and the data set therefore demands the employment of the Auto Regressive Distributive Lag (ARDL) model as the preferred technique for econometric estimation.

4.2. Analysis and Discussion of Results

With the adoption of the ARDL model because of the mixed order of integration from the unit root test result, a bound test was conducted to ascertain the existence of cointegration, that is, to find out if there is a long run relationship between the variables. These tests are as presented in the tables below

Table 2: ARDL Bounds Test for EODB (GLOB, NFDI, IMCAPG, GOVEFF)

Test Statistic	Value	K
F-statistic	5.118567	5
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Source: Computed by Author using E-view, 2024

The results indicate the existence of a long run cointegrating relationship among the variables in the ease of doing business equation. This is because the F- statistic of 5.11 exceeds the lower and upper bounds critical value at the 5 and 10 significance level. Consequently, the null hypothesis of no long run relationship is rejected. Next, the study proceeds to estimate the parameters of the specified model. The result is as shown in table 3.2

Table 3: Short Run Result for Ease of Doing Business Equation

Dependent Variable: EODB

Variable	Coefficient	Std. Error	t-Statistic	Prob
D(OPEN)	0.276069	0.171880	1.606167	0.1256
D(OPEN(-1))	0.584625	0.205324	2.847333	0.0107
D(OPEN(-2))	-0.053466	0.204314	-0.261687	0.7965
D(OPEN(-3))	-0.713596	0.214756	-3.322825	0.0038
D(NFDI)	0.245350	0.127750	1.920547	0.0708
D(NFDI(-1))	-0.224877	0.138246	-1.626642	0.1212
D(NFDI(-2))	-0.267429	0.114779	-2.329953	0.0316
D(NFDI(-3))	0.379253	0.120055	3.159001	0.0054
D(IMCAPG)	0.000001	0.000001	2.043240	0.0559
D(GOVEFF)	3.818066	2.895233	1.318742	0.2038
D(GOVEFF(-1))	-3.493892	3.502733	-0.997476	0.3318
D(GOVEFF(-2))	4.494306	3.034878	1.480885	0.1559
CointEq(-1)	-0.546197	0.130512	-4.185044	0.0006
R-squared	0.725083		Durbin-Watson stat	2.292352
Adjusted R-squared	0.680713			
F-statistic	2.967149			
Prob(F-statistic)	0.014382			

Source: Researcher's Analysis

The results on table 3.3 for ease of doing business equation used as a measure for competitiveness shows that some variables bear signs that are consistent with economic theory. For instance, the estimated coefficient of openness at levels and its first lag bears a positive relationship with ease of doing business, while its second and third lags are negatively related. For the first lag in particular, a unit improvement in the openness is associated with 0.5846 increase in competitiveness level in Nigeria. It is also observed that both the first and the third lags of the estimated were statistically significant at the five per cent level. This means in specific periods in the short run, openness was a significant factor influencing the level of competitiveness in Nigeria.

Similar observations are made concerning the relationship and impact of foreign direct investment on competitiveness levels. Out of the four estimated parameters of net foreign direct investment, two indicated a significant positive relationship with the dependent variable. These are NFDI at levels as well as its third lag. Specifically, a unit increase in foreign direct investment inflow into Nigeria, on the average leads to 0.379 rise in competitiveness, while similar increase is associated with a 0.245 increase in the dependent variable, *ceteris paribus*. These estimated positive relationships with competitiveness were also associated with acceptable statistical significance levels. However, NFDI for both the first and second lags were inconsistent with a priori expectations. On balance, it appears that FDI is a significant variable influencing the level of competitiveness or ease of doing business in Nigeria.

The estimated parameter of imports on capital goods indicate a positive and significant relation with competitiveness, though the size of its effect seems to be very small (0.000001), indeed negligible. The effectiveness of government institutions reveals that the quality of institutions exerted a negative relationship with competitiveness in its second lag, while the first and its estimated coefficient at levels as well as its second lag were positively related to the dependent variable. Looking at the significance level, it can be concluded that institutional quality exerted no significant influence on the competitiveness in Nigeria.

The result further reveals that the error correction term is both negatively signed and statistically significant at the one per cent level. Its estimated value of 0.546 indicates an average speed of adjustment from the short run to the long run equilibrium values. In other words, short run deviations in the model are systematically corrected to their long run levels at a speed of about 55 per cent yearly.

Other diagnostic test results indicate, for instance, an adjusted R-squared of 0.680. This means that about 68 percent of total variation in the dependent variable is accounted for by the explanatory variables. However, the overall F-statistic (2.9671) which speaks of the overall significance of the short run model can be concluded to have a good fit, as it is significant at the one percent level. Equally acceptable is the Durbin-Watson statistic of 2.29. Based on the thumb's rule, we can conclude first order autocorrelation is not a challenge to the specified model and the associated results.

Table 4: ARDL Bounds Test for Human Development Index (OPEN, NFDI, EODB, GDI and GOVEFF)

Test Statistic	Value	K
F-statistic	15.48527	5
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

Source: Computed by Author using E-view, 2024

The result of the bounds test to investigate the existence of cointegration among the variables in human development equation as seen in table 3.4 points out that the variables are cointegrated. This means there is long run relationship between the variables. This is because the calculated F-statistic of 15.48 is greater the critical values at all significance levels. Based on the cointegration results, table 3.4 presents the estimated results of human development equation.

Table 5: Short Run Result for Human Development Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob
D(EODB)	0.000400	0.000344	1.161349	0.2592
D(RER)	0.000060	0.000034	1.741342	0.0970
D(RER(-1))	-0.000036	0.000033	-1.099992	0.2844
D(GDI)	0.000000	0.000000	0.695758	0.4946
D(GDI(-1))	0.000000	0.000000	-1.761424	0.0934
D(GDI(-2))	0.000000	0.000000	-2.759082	0.0121
D(INFL)	-0.000027	0.000032	0.850477	0.4051
D(OPEN)	0.001041	0.000333	3.131049	0.0053
D(OPEN(-1))	0.000218	0.000379	0.575446	0.5714
D(OPEN(-2))	0.000720	0.000335	2.145685	0.0444
CointEq(-1)	-0.194720	0.076334	-2.550890	0.0190
R-squared	0.880020		Durbin-Watson stat	2.034589
Adjusted R-squared	0.790035			
F-statistic	9.779620			
Prob.(F-statistic)	0.000004			

Source: Researcher's Analysis

The result from the table 3.5 above reveal that real exchange rate at the current period positively impacts on human or human capital development. It shows that a unit increase in real exchange rate is associated with 0.000060 increase in human capital development. The estimated real exchange rate is also statistically significant in the short run, meaning that the variable is vital in promoting human capital development in Nigeria. The result further reveals that openness bears a positive and significant effect on human capital development in the short run. In particular, all the three estimated parameters of openness indicate that the latter exerts a positive influence on human capital development. Besides its first lag, both the current and second estimated parameter indicate that openness is a significant variable in enhancing or influencing Nigeria's human capital development.

Furthermore, table 3.5 reveals that in the short run ease of doing business and inflation are not significant factors impacting on human capital development in Nigeria. Similarly, the estimated coefficient of gross domestic investment reveals that the latter has a negative influence on human capital development in the first and second lags. It must be noted that generally, the magnitude of the estimated parameters is indeed very negligible, showing that in the short run, these factors exert weak influence on human capital development.

Specifically, a unit increase in ease of doing business will lead to 0.000400 increase in human capital development in Nigeria in the short run (Table 3.5). The result further shows that a unit increase in gross domestic investment in Nigeria will not contribute to human capital development in Nigeria in the short run. This result reveals that domestic investment has no much influence on human capital development of the country. This result is at variance with a priori expectation and may not be unconnected with the fact that most of the multinationals companies operating in the country repatriate profit made in Nigeria to their countries of origin and they also bring in expatriates from their country of origin at the expense of Nigerians.

Tables 3.5 also present diagnostic results of the estimated equation. It reveals that 79 percent of the factors influencing human capital development in Nigeria is explained by the variables captured in the human development index equation and the remaining 21 percent is the unexplained variation captured by the error term. This is further confirmed by the Durbin-Watson (DW) Statistics of 2.03458 which shows there is no autocorrelation. The F-Statistic of 9.779620 and its probability value of zero shows that the estimated parameters of the model are jointly significant in explaining the impact and relationship of the explanatory variables on the dependent variable.

4.3. Policy recommendations

In view of the above findings, the following policy recommendations are proffered:

- (i) Government should encourage the continued integration of the Nigerian economy into the broader global structure. This it can do by encouraging the inflow of foreign direct investment into the economy. This would improve the level of technology as domestic firms would in the long run adapt or adopt the technology into the local production function
- (ii) Government should continuously work to improve the quality of institutions in Nigeria. The quality of institutions would significantly boost the economy's level of competitiveness as well as aid in the process of human capital development.
- (iii) Consistent and well-targeted monetary policies should be pursued by monetary authorities in order to stabilize the price of the domestic currency (the naira) and curb inflation. This is because an unstable exchange rate regime and persistent inflation rates erode the confidence of agents to invest in the economy, thus compromising the level of competitiveness.
- (iv) Human capital development in Nigeria can be achieved by promoting ease of doing business. The government can do this by making registration of businesses less cumbersome and providing credit facilities to investors. This will encourage investment, productivity, competitiveness and human capital development.
- (v) The results revealed that globalisation, FDI, and Ease of Doing Business have positive impact on human capital development in Nigeria. Therefore, government should make policies that will enable foreign investors to invest in Nigeria and also make policies that will open the economy which will encourage competitiveness and thus development of human capital.

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L'Eco-féminisme dans Les Choses : Une Histoire des années soixante de Georges Perec

***¹Allam, J. N. & ²Udo, I. J.**

¹Department of French, Federal College of Education Zaria, Kaduna State, Nigeria

²Department of French, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom
State, Nigeria

*Corresponding Author Email: nguvanallam@gmail.com, Tel: +2347030073799

Abstract

Georges Perec is a 20th century French writer known for his works on experimental literature. As a member of the literary movement OULIPO, his works are anchored on literary experimentation where he works on themes of loss, memory, identity, happiness, exploitation etc. having lost his parents at a young age during the Second World War, themes of loss and emptiness are omnipresent in all his works. He expresses these sentiments through the use of literary constraints. In his work *Les Choses*, he reflects on the superficiality of the modern society and the manner in which material possessions can replace more profound aspirations. The novel describes the daily life of a young couple, Jerome and Sylvie. They think of a good life for themselves tying it to material things they have and the ones they aspire to acquire. Eco-feminism is an approach that explores the intersections between the oppression of women and the exploitation of nature putting evidence on the how these two forms of oppression are interdependent. The theory pleads for a transformation towards equal rights and preservation of women and nature. In this work we have read the novel *Les Choses* and using the theory of ecofeminism, we have analyzed the novel and come to the conclusion that even though Perec is not an ecofeminist theorist and has not depicted it in this novel but his work can be read at the angle of ecofeminism. It reveals the plurality of George Perec and the innovative nature of his writings.

RESUME

Dans *Les Choses* il s'agit d'une réflexion sur la superficialité de la société moderne et la manière dont les possessions matérielles peuvent remplacer des aspirations plus profondes. Le roman décrit la vie quotidienne d'un jeune couple, Jérôme et Sylvie. Ils se font une idée du bonheur, liée aux choses qu'ils possèdent ou veulent acquérir. L'éco-féminisme est une approche qui explore les intersections entre l'oppression des femmes et l'exploitation de la nature, en mettant en évidence comment ces deux formes d'oppression sont interdépendantes et en plaidant pour une transformation vers des sociétés plus égalitaires et respectueuses de l'environnement. Dans cette communication, nous avons lu et analysé le roman *Les Choses*, en utilisant la théorie de l'Eco féminisme. Nous exposons comment la vie de Jérôme et Sylvie révèle l'oppression et l'exploitation de la nature. Nous concluons que Perec lui-même n'a pas clairement articulé l'éco-féminisme dans son travail mais l'exploration minutieuse de la vie quotidienne et

l'attention aux détails pourraient être interprétées comme une réflexion implicite sur les relations entre l'humain et la nature, offrant ainsi des perspectives éco-féministes.

Keywords: Eco-féminisme, Consommation les choses, Oppression, Exploitation, Georges Perec, OULIPO

INTRODUCTION

Georges Perec est un écrivain français du XXe siècle reconnu par son oeuvre sur la littérature expérimentale. Il est membre d'un mouvement littéraire appelé Ouvrage de la Littérature Potentielle (OULIPO). Perec joue avec les mots pour produire la littérature potentielle où avec des contraintes littéraires il crée des oeuvres spectaculaires. Les thèmes principaux dans l'oeuvre de Perec comportent sur la perte, le bonheur, la mémoire, l'identité etc, le manque et le vide étant des thèmes omniprésents dans toute son oeuvre. Dans ses oeuvres, Perec montre une sensibilité à l'environnement et à la nature, mais il ne les place pas au centre de son écriture.

L'éco-féminisme est un mouvement qui conçoit l'exploitation et la domination des femmes, des minorités et de la nature comme un tout. La raison est simple : pour les Eco féministes, cette triple domination est considérée comme la conséquence d'un système patriarcal, capitaliste et colonial dominé par les hommes, dans lequel on cherche à exploiter plus pour produire (toujours) plus. Plus largement, l'éco-féminisme est un mouvement qui lutte contre toute forme d'oppression, envers les femmes, les animaux, la nature et les minorités. Se dire éco-féministe, c'est donc souhaiter un changement de système global, c'est vouloir se battre contre toutes les formes d'inégalités sociales et contre les discriminations de race et de sexe.

Dans le cadre de cet article, l'éco-féminisme désigne la position selon laquelle il existe d'importants rapports, entre la domination où les femmes ont été soumises et celle qui s'est exercée à l'encontre de la nature. L'éco-féminisme nous fournit un cadre théorique distinct au sein duquel il est possible de concevoir à nouveaux frais les thèmes dans l'oeuvre de Georges Perec qui inconsciemment, prennent au sérieux les interconnexions entre la domination des femmes et celle de la nature, l'exploitation des choses matérialistes dans son oeuvre. Même si Perec n'est pas un théoricien de l'éco-féminisme, et son oeuvre est plus souvent étudiée dans le contexte de la littérature expérimentale et de la littérature oulipienne, nous avons examiné son texte, "Les Choses" sous un angle éco-féministe en mettant en évidence les questions de consommation, de domination, et de rapports de pouvoir, qui sont des thèmes importants de ce mouvement.

Qu'est-ce que c'est l'éco-féminisme?

Les racines du déploiement des pensées et pratiques éco-féministes se trouvent en grande partie aux États-Unis dans les années 1970. Dans l'année 1974 la Féministe française Françoise d'Eaubonne a forgé le néologisme « éco-féminisme » dans son oeuvre *Le Féminisme ou la mort*. Inspiré par le féminisme, l'éco-féminisme a développé la revendication d'une certaine sensibilité féminine au vivant, mettant en parallèle la domination des hommes sur la nature et sur les femmes.

Le Féminisme ou la Mort, de Françoise d'Eaubonne paru en 1974 devient donc, l'ouvrage de référence sur l'éco-féminisme. Françoise d'Eaubonne affirme que si le monde refuse la mutation offerte par le féminisme, « il est condamné à mort ». Elle luttera notamment toute sa vie pour une sexualité non-reproductive, une lutte à la fois féministe et écologique. Pour elle, féminisme et écologie vont de pair, car les deux ont le même ennemi, la société masculine qui fait tout pour maintenir son pouvoir sur les femmes et sur la nature. Contre ce pouvoir, il convient d'opter pour la « contre-violence », car la non-violence s'avère peu efficace, et frapper sans tuer.

Pour Pascale d'Erme l'éco-féminisme est l'union de toutes les causes. « La convergence des luttes féministes, écologistes, antinucléaires et pacifistes contre toute forme de domination et de destruction du vivant est la toile de fond de l'éco-féminisme » (p.23)

Dans un entretien avec Juan Tortosa le 23 février 2012 traduit par Inès Calstas, Alicia PULEO décrit l'éco-féminisme comme « une forme de résistance contre la domination, la convoitise sans limites et la fantaisie d'omnipotence qui fait de l'humain un être totalement différent et détaché de la nature ». Selon elle, L'éco-féminisme n'est pas seulement la conservation des espèces en voie de disparition, mais il englobe aussi la préoccupation pour la justice envers les humains à l'écologie sociale :

Je dois, toutefois, souligner que je réponds à la question depuis ma proposition éco-féministe. Mais il y a différentes manières de penser l'éco-féminisme, certaines, par exemple, ne s'intéressent pas au sujet de l' « Autre animal ».

Ce que tout le monde partage est la préoccupation pour les sujets écologiques qui concernent surtout les femmes. Nous, les femmes, sommes vulnérables biologiquement et hormonalement aux produits toxiques utilisés actuellement, et nous sommes concernées autant comme consommatrices que productrices. (Puleo, 2012)

Selon Catherine Larrère, l'éco-féminisme pose au centre de sa réflexion la question des relations de genre et de domination dans l'approche de la protection environnementale. « L'éco-féminisme est de s'interroger sur le lien entre les femmes et la nature des deux côtés. Dire aux femmes que le rapport à la nature les intéresse, et que donc un mouvement féministe qui ne se pose pas la question de la nature n'est pas un mouvement féministe complet. Et puis, c'est dire aux environnementalistes que la question des femmes les intéresse » L'éco-féminisme, écrit Catherine Larrère (2012, p. 105) « a mis au cœur de sa réflexion les connexions qui existent entre la domination des hommes sur la nature et celle qu'ils exercent sur les femmes ». Catherine Larrère voit l'éco-féminisme comme un rejet de l'idée que les femmes doivent ressembler aux hommes pour obtenir l'égalité. Pour elles, cela n'en vaut pas la peine au vu du résultat pour la planète ! Elles vont chercher ailleurs, d'autres manières qui excluent, non pas les hommes, mais le patriarcat. Et appeler les hommes à les rejoindre.

Dans son livre *Rêver l'obscur*, Starhawk effectue une distinction entre le pouvoir-sur et le pouvoir-du-dedans : le pouvoir-sur est caractérisé par la domination, le contrôle et l'utilisation de la police et des forces armées pour imposer sa volonté ; le pouvoir-du-dedans renvoie à la créativité et au déploiement de la puissance d'agir. Laurine Omnès (2023) discute l'opinion de Catherine Larrère sur cette idée. Elle dit que Catherine Larrère « relie alors cette distinction à la distinction spinoziste entre *potentia* et *potestas* : le développement de la puissance d'un côté ; le pouvoir du tyran de l'autre. La politique écoféministe n'est donc pas un pouvoir-sur assimilable à une *potestas*. Il s'agit d'un pouvoir-du-dedans assimilable à une *potentia*, un « style politique » qui inclut le pluralisme ». L'éco-féminisme est un mouvement et une approche théorique qui établit un lien entre les questions environnementales et les questions de genre. Il repose sur l'idée que les oppressions subies par les femmes et les oppressions infligées à la nature sont liées, car elles découlent d'une même logique de domination, de pouvoir et d'exploitation.

Il existe deux courants majoritaires dans l'éco-féminisme. Le premier est un courant matérialiste, inspiré des théories de Marx. Il s'attache à chercher des solutions concrètes sur le terrain pour lutter contre l'impact du changement climatique sur les femmes. Ce groupe compose des pionnières comme Françoise d'Eaubonne, Vandana Shiva et Maria Mies. Le deuxième courant majoritaire est un courant spirituel dont le précurseur est Starhawk. Ce courant promeut la réappropriation de leur corps par les femmes et de leurs liens avec la Nature. Il réhabilite le personnage de la sorcière pour en faire une figure politique. Les différentes branches de l'éco-féminisme ont toutes en commun de mêler souci écologiste et souci féministe. Elles ont identifié la cause unique de l'oppression des femmes et de l'exploitation de l'environnement : le système capitaliste et patriarcal. Elles luttent contre celui-ci de différentes manières.

Parmi tous, l'éco-féminisme a les principaux points qui sont premièrement, critique de la dualité homme/femme et nature/culture : L'éco-féminisme remet en question la division traditionnelle entre le masculin (associé à la culture, la rationalité) et le féminin (associé à la nature, l'irrationnel). Il soutient que cette division a été

utilisée pour justifier l'exploitation des femmes et de la nature. Il y a aussi l'écologie comme féministe où la protection de l'environnement et la lutte pour l'égalité des genres sont liées. Ils soutiennent que la valorisation de la nature est liée à la valorisation des activités traditionnellement associées aux femmes, telles que les soins et la préservation. On a aussi la critique de la hiérarchie et de la domination. C'est comment les structures de domination et de pouvoir qui oppriment les femmes sont parallèles à celles qui exploitent la nature. Ici l'éco féminisme met en lumière comment ces oppressions sont interconnectées. La solidarité et activisme ici les éco-féministes encouragent la solidarité entre les mouvements écologistes et féministes. Ils militent pour un changement social qui remettrait en question les systèmes de pouvoir patriarcaux et exploitants de l'environnement.

L'éco-féminisme dans la littérature française

L'éco-féminisme littéraire en France n'est pas simplement une tendance éphémère, mais plutôt une évolution naturelle de la pensée féministe. Les autrices contemporaines insufflent une vitalité nouvelle à ce dialogue, transformant la littérature en un espace d'exploration des problématiques cruciales de notre époque. Ces récits offrent une contribution significative à la conscientisation sociale, invitant les lecteurs à envisager une société plus égalitaire et respectueuse de l'environnement. La littérature devient un catalyseur puissant pour le changement social et environnemental. Des écrivaines telles que Simone de Beauvoir ont initié la réflexion féministe en France. Son ouvrage fondamental *Le Deuxième Sexe* continue d'influencer la pensée féministe en France, tout en servant de fondement à une nouvelle compréhension des liens entre genre et environnement. Le manifeste pionnier de Françoise d'Eaubonne, *Le Féminisme ou la Mort*, demeure une référence incontournable dans le canon éco-féministe français. Cette autrice a jeté les bases d'une pensée intersectionnelle, invitant à une réflexion cruciale sur les systèmes de pouvoir tant dans le domaine du genre que de l'environnement.

L'éco-féminisme, mouvement intellectuel qui explore les liens entre la condition féminine et les enjeux écologiques, s'incarne de manière vibrante dans la littérature française contemporaine. Des autrices engagées alimentent ce dialogue complexe, apportant des perspectives novatrices sur les interconnexions entre les oppressions de genre et les crises environnementales.

L'éco-féminisme dans l'oeuvre de Georges Perec : une étude analytique de *Les Choses*: Une histoire des années soixante.

Georges Perec, est reconnu pour sa compétence à explorer la vie quotidienne uniquement de sa manière ludique et sociologique. Chez Perec, l'écriture est d'abord une activité ludique qui précède l'assemblage des mots et l'écriture à proprement parler. Il dit que :

J'écris parce que j'aime manipuler les mots et manipuler des citations aussi, ou des descriptions. Dans un roman, Jules Verne a entièrement copié une page d'un dictionnaire encyclopédique, et moi aussi, en empruntant des citations, j'utilise cette possibilité. J'aime mélanger le vrai, le demi-vrai et le faux. (2019, p. 86)

Les Choses, publié en 1965 a pour sous-titre : *Une histoire des années soixante*. L'histoire est une observation minutieuse de la société de consommation des années 1960. Cependant, en l'examinant de plus près, nous pouvons déceler des éléments qui s'alignent avec les préoccupations contemporaines de l'éco-féminisme. Mais avant de faire cela, il est important de donner un aperçu bref du roman.

Dans le roman, l'action se situe sur un fond de la guerre d'Algérie. Un jeune couple, Jérôme et Sylvie, lancés dans la vie active après des études écourtées, rêvent de devenir riches tout en préservant leur liberté. Ils se font embaucher par des agences de publicité pour lesquelles ils se livrent à des enquêtes de motivation en plein essor. Il s'agit de leur obsession pour la consommation de biens matériels et leur quête du bonheur à travers la possession de choses. Le roman décrit leur quotidien, leurs aspirations et leurs frustrations. Il met en lumière le vide existentiel qui découle de leur quête de réussite sociale et matérielle. *Les Choses* est un roman qui interroge les

valeurs de la société contemporaine, soulignant le contraste entre le désir de possessions matérielles et l'accomplissement spirituel ou émotionnel. Perec utilise un style précis et observateur pour dépeindre les détails de la vie quotidienne de ses personnages, créant ainsi un tableau critique de la France des années 1960.

Le thème principal dans *Les Choses: Une histoire des années soixante*, est la société de consommation et la recherche du bonheur à travers la possession de biens matériels. Perec explore comment la vie quotidienne, les objets et la quête de confort matériel influencent les individus et les relations humaines. Il s'agit d'une réflexion sur la superficialité de la société moderne et la manière dont les possessions matérielles peuvent remplacer des aspirations plus profondes. Cependant, *Les Choses* peut être analysé sous un angle éco-féministe en examinant comment il met en scène les questions de consommation, de pouvoir, d'aliénation et d'oppression, tout en montrant comment ces thèmes sont liés à la relation entre l'humanité, en particulier les genres, et la nature. Cette analyse permet de mettre en lumière certaines dimensions éco-féministes dans l'oeuvre de Perec. Les thèmes sont profondément tissés dans la structure narrative. Voici quelques éléments éco-féministe dans l'oeuvre de Georges Perec.

Consommation et aliénation

Le roman explore la vie d'un couple, Sylvie et Jérôme, qui est obsédé par la consommation de biens matériels. Ils sont présentés comme des étudiants désillusionnés qui se conforment au rôle de jeune cadre de la société et commencent leur quête sans fin du potentiel promis en consommant tout ce que la société a à offrir. Cette nouvelle tendance du consumérisme s'empare rapidement de Sylvie et Jérôme qui aspirent à ressembler à l'image idéalisée projetée par la société, notamment dans l'hebdomadaire omniprésent *Madame Express* « Ils auraient su s'habiller, regarder, sourire comme des gens riches » (p. 17). Les deux premiers chapitres sont exclusivement dictés par la prééminence des objets décrits dans un appartement. Par exemple : « Il y aurait une cuisine vaste...à reflets métalliques, des placards partout, une belle table de bois blanc au centre, des tabourets, des bancs. » (p.14.) Il y a une signification plus profonde au positionnement délibéré de ces choses par Perec au premier plan du livre, et il convient de noter que cette description centrée sur l'objet doit être considérée comme une représentation typique d'une société vide plutôt que spécifiquement de Jérôme et Sylvie. Perec peint un portrait sans concession de la société de consommation et montre comment la recherche de bonheur à travers les biens matériels peut mener à l'aliénation et à la déshumanisation. Cette obsession reflète une société de consommation effrénée, qui peut être interprétée comme un exemple de l'exploitation de la nature (les ressources) pour satisfaire les désirs humains. L'éco-féminisme souligne comment cette exploitation de la nature est souvent liée à une mentalité de domination.

Perec dépeint le couple comme une unité de consommation dépersonnalisée et les lignes suivantes attestent au fait : « Ils ne méprisaient pas l'argent. Peut-être au contraire, l'aimaient-ils trop: ils auraient aimé la solidité, la certitude, la voie limpide vers le futur. Ils étaient attentifs à tous les signes de la permanence : ils voulaient être riches ». (p. 96)

Domination et pouvoir

L'éco-féminisme examine les relations de pouvoir entre les genres et la façon dont elles sont liées à l'exploitation de la nature. Dans *Les Choses*, on peut voir comment le personnage masculin de Jérôme, exerce un certain pouvoir sur le personnage féminin de Sylvie, illustrant ainsi la hiérarchie de genre. La masculinité de Jérôme dans *Les choses* est représentée à travers ses ambitions, son rôle dans sa relation et son désir de contrôle, qui sont tous profondément liés aux valeurs consuméristes qui conduisent finalement à sa désillusion et à celle de Sylvie. Perec décrit Jérôme et ses amis comme un gentleman anglais. « Jérôme et ses amis étaient, non pas le gentleman anglais, mais la très continentale caricature » (p. 25). En considérant son amour sur les allusions, Perec fait ici, allusion au roman de Douglas Sutherland *The English gentleman* où Sutherland dépeint un gentleman anglais comme un homme qui est fier, qui aime contrôler, qui aime le luxe, qui se voit supérieur et possède l'amour sur des

valeurs consuméristes. Cette description de Jérôme dévoile l'aspect de l'éco-féminisme dans *Les Choses* bien que Perec n'aborde pas ce thème dans le roman.

L'aspiration à posséder des biens matériels conduit à une forme de domination. Les personnages de Jérôme et Sylvie, influencés par les normes sociales de consommation, deviennent esclaves de leurs désirs de possession, « ils n'avaient pas, hors de lui, de vie réelle » (P.54). Cette quête de statut matériel crée une hiérarchie sociale où ceux qui ont plus de biens exercent une forme de pouvoir sur les autres. La domination se manifeste également à travers la publicité et les médias qui façonnent les désirs et les comportements plutôt l'hebdomadaire *L'Express*. Pour Jérôme et Sylvie et bien sur leurs amis, *L'Express* était l'hebdomadaire dont ils faisaient le plus grand cas. « *L'Express* et lui seul, correspondait à leur art de vivre » (P. 45)

Désir matérialiste et dépossession

L'éco-féminisme met en avant la notion de dépossession, où l'accumulation de biens matériels par certaines classes de la société se fait au détriment de la nature et des populations marginalisées. Jérôme et Sylvie, à travers leur amour de bien-être, ils devenaient les victimes de leur oppression. L'auteur dit que « leur amour du bien-être, du mieux-être, se traduisait le plus souvent par un prosélytisme bête » (p. 23) *Les Choses* dépeint comment le désir matérialiste de Jérôme et Sylvie les conduit à une certaine dépossession de leur identité et de leur humanité, une dépossession qui peut être liée à l'exploitation de la nature. Paradoxalement, la quête incessante de biens matériels peut également entraîner une dépossession intérieure. Jérôme et Sylvie, bien qu'entourés d'objets, peuvent se sentir vides et aliénés. La course à la consommation peut les priver de leur identité authentique, les transformant en simples consommateurs sans réelle satisfaction. La dépossession se manifeste non seulement matériellement, mais aussi au niveau émotionnel et existentiel. Ce thème manifeste dans les personnages de Jérôme et Sylvie. Ils ont devenu mégalomanes, la visite d'une simple exploitation agricole se transforme en une vision hallucinante de gigantisme alimentaire, vision qui, dans un second temps, se métamorphose en construction d'une ville utopique et paradis urbain. Perec décrit leur vie comme « une vie sans rien » (p. 139)

L'oppression invisible

L'éco-féminisme souligne l'oppression invisible, notamment celle des femmes et de la nature, qui est souvent négligée ou ignorée. Dans le roman, la vie quotidienne des personnages et leur aliénation face aux objets matériels peuvent être vues comme une forme d'oppression invisible, tout comme l'exploitation de la nature qui est souvent dissimulée dans une société de consommation. Perec explore l'idée que l'opération invisible de la société de consommation est insidieuse. Les mécanismes qui conditionnent les individus à rechercher constamment la possession ne sont pas toujours évidents. L'influence des médias, de la publicité et des normes sociales opère de manière subtile, dictant les choix et les comportements des personnages sans qu'ils en soient pleinement conscients. Cette opération invisible crée une aliénation progressive et rend difficile la remise en question des valeurs dominantes.

Conclusion

L'éco-féminisme littéraire en France est une évolution naturelle de la pensée féministe. Les autrices contemporaines insufflent une vitalité nouvelle à ce dialogue, transformant la littérature en un espace d'exploration des problématiques cruciales de notre époque. La littérature française, en se tournant vers l'éco-féminisme, élargit son champ d'exploration. Ces récits offrent une contribution significative à la conscientisation sociale, invitant les lecteurs à envisager une société plus égalitaire et respectueuse de l'environnement. Dans ce dialogue entre genre et nature, la littérature devient un catalyseur puissant pour le changement social et environnemental.

On puisse interpréter certains aspects de l'oeuvre de Georges Perec à la lumière de l'éco-féminisme, mais ce n'était pas son principal domaine d'exploration littéraire. Selon Claude Burgelin (2002, p.167), « les détours choisis

par Perec l'amènent à explorer des zones moins visibles ou dicibles ». Ainsi dans *Les Choses*, à travers ces thèmes entrelacés, Georges Perec offre une analyse critique de la société de consommation, soulignant les conséquences de la recherche obsessionnelle de biens matériels sur la vie individuelle et collective.

Bien que dans ses oeuvres, Perec montre une sensibilité à l'environnement et à la nature, il ne les place pas au centre de son écriture. Georges Perec n'aborde pas explicitement l'éco-féminisme dans son oeuvre, mais son exploration minutieuse de la vie quotidienne et son attention aux détails pourraient être interprétées comme une réflexion implicite sur les relations entre l'humain et la nature, offrant ainsi des perspectives éco-féministes.

En conclusion, l'exploration de l'éco-féminisme à travers *Les Choses* de Georges Perec offre une perspective intrigante sur la manière dont l'auteur aborde les relations entre les individus, la société et l'environnement. En dévoilant les liens subtils entre la consommation, le genre et la nature, Perec souligne la nécessité d'une réflexion approfondie sur notre rapport au monde. Cette dimension éco-féministe enrichit la compréhension de l'oeuvre en lui conférant une dimension engagée et actuelle, invitant le lecteur à questionner les structures sociétales et écologiques qui influent sur notre existence. Cependant, toute affirmation à ce sujet resterait une interprétation subjective, car Perec lui-même n'a pas clairement articulé de telles idées dans son travail. Ce travail expose la pluralité de Georges Perec et le caractère innovant de son écriture, et ouvre des nouvelles voies dans l'étude de ses oeuvres.

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Comparative Studies of the Effects of Natural and Artificial Buffered Wastes on *Pleurotus ostreatus* and *Ganoderma lucidum* Performances

^{*1}Ben, M. G. & ²Ekong, U. J.

^{*1&2}Department of Biology, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

*Corresponding Author Email: benmayen9@gmail.com, Tel: +2348025803378

Abstract

Comparative studies of the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* performances grown on empty fruit bunch of oil palm (EFBOP) were carried out using standard microbiological methods. *Ganoderma lucidum* and *Pleurotusostreatus* were cultivated on both natural buffer (decay banana pseudostem extract T1) and artificial buffer (agricultural lime T2)). Biweekly observations were done for 42 days for complete colonization. It was observed that the ramification rates of *Pleurotusostreatus* grown on natural and artificial buffers when measured had the following data; natural buffer waste (T1) as 11.5, 13.9, 15.6, 16.9, 17.8, and 19.7cm while the artificial buffered wastes (T2) had 7.2, 9.9, 12.1, 14.8, 15.4 and 17.1cm. The fruiting bodies of *Pleurotus* grown on T1 and T2 were observed and weighed for 3 weeks. T1 yielded 184, 307, and 500kg on the 1st, 2nd, and 3rd flushes respectively while T2 showed 127, 170, and 230kg respectively on the 1st, 2nd, and 3rd flushes respectively. The ramification rates of *Ganoderma lucidum* grown on T1 and T2 of EFBOP had the following data 0, 0, 4.3, 9.8, and 11.8 and 18.6 cm while T2 recorded 0, 0, 3.7, 8.5, 9.7 and 15.3 cm respectively. The fruiting bodies of *Ganoderma* yielded on T1 0, 0, and 5.0kg on the 2nd and 3rd flushes respectively while T2 showed the minimum fruiting body of *Ganoderma lucidum* 0,0 and 4.0kg on the 2nd and 3rd flushes respectively. The T1 with natural buffered wastes supplemented with decay banana pseudostem extract (DBPE) colonized faster regarding some days to complete mycelial growth and yielded more mushrooms than T2 of agricultural lime. *Ganoderma lucidum* had longer ramification and fruiting periods than period than *Pleurotus*. Data generated were analyzed by simple mean, standard deviation, and percentage. It is therefore recommended that natural buffers should be used for the cultivation of mushroom since it contains no artificial additives that could be harmful to health. Farmers are encouraged to use locally available substrates from agricultural by-products that are abundant and economically feasible.

Keywords: Comparative studies, Natural and artificial buffered, Wastes, *Pleurotus ostreatus*, *Ganoderma lucidum*

1.0. INTRODUCTION

Oyster mushroom (*Pleurotus* spp.) is commercially cultivated worldwide for its medicinal, nutritional properties and incredible taste (Tesfaw *et al.*, 2015). One of the most charming points of the cultivation of mushrooms is that they are grown on agricultural wastes procured at low prices or even for free and to conserve our environment by recycling wastes (Khan *et al.*, 2012).

Mushrooms are sources of easily absorbed proteins, carbohydrates, amino acids, B vitamins (thiamine, riboflavin, and niacin), vitamin D, and mineral salts (calcium, phosphorus, iron), characterized by low fat concentration (Jin *et al.*, 2018). The fruiting bodies of fungi of the *Pleurotus* genus are a rich source of micro and macro elements, such as copper, iron, zinc and sodium, potassium, magnesium, and phosphorus. Their amount depends to a large extent on the species, age, and size of the fungus, as well as the growing conditions. The mushroom pilei contain primarily potassium and phosphorus, whose content varies between 10-20 mg/100 g (Mbassi *et al.*, 2018). Straw mushrooms promote the production of body fluid rich in protein, fat, iron, zinc, various amino acids, and large amounts of Vitamin C (Singh *et al.*, 2020).

In addition, mushrooms are considered a healthy diet food due to their health benefits (Mowsurni and Chowdhury, 2013). The major medicinal properties of mushrooms have been documented (Mowsurni and Chowdhury, 2013). The medicinal properties attributed to mushrooms include antibiotic, anticancer, immune response stimulating effects, antiviral activities, and blood lipid-lowering effects (Alam *et al.*, 2007). Oyster mushroom has high medicinal value, and hence consumption can aid in ameliorating and preventing many ailments which include high blood, kidney problems, diabetes, cholesterol level, impaired immune response, hepatitis B, chronic, hypertension, heart disease, gastric cancers, fatigue syndrome and microbial infection (Mowsurni and Chowdhury, 2013).

Furthermore, mushrooms have medicinal benefits such as antioxidants that defend the body against free radicals. Mushroom extracts are inhibitory to sarcoma, and generally immunochemical from mushroom species shown anticancer (Mahendran *et al.*, 2012). Mushroom extracts also can protect DNA a lot of mushroom species possess highly potent immune enhancers against cancer for both humans and animals (Wani *et al.*, 2010).

Ganoderma lucidum has been recognized as a medicinal mushroom for over 2000 years and its powerful effects have been documented in ancient scripts. Besides promoting longevity, it has unique properties of strengthening the immune system (Valverde *et al.*, 2015). It is a popular remedy to treat conditions like chronic hepatitis, hypertension, cancer, low blood pressure, high blood pressure, diabetes, rheumatism, heart problems, paralysis, ulcers, arthritis, asthma, tiredness, hepatitis A, B, and C, sterility, psoriasis, mumps, epilepsy, and alcoholism (Zang, 2009). It refreshes the body and mind, delays aging, and is also effective in reducing the blood glucose level of diabetic patients after two months of treatment. *G. lucidum* has been used in Traditional Chinese Medicine (TCM) as a remedy to treat more than 20 different illnesses which include migraine and headache, hypertension, arthritis, bronchitis, asthma, anorexia, gastritis hemorrhoids, hyper-cholesterolemia, nephritis, dysmenorrhoea, constipation, lupus erythematosus, hepatitis, leucopenia, cardiovascular problems and cancer (De Silva *et al.*, 2013). It also has a therapeutic effect on insulin resistance, reduces the risk of prostate cancer, and can help treat a variety of conditions associated with metabolic syndrome

Various important health products have been made from mushrooms, and some of these efforts are currently being translated into healthcare products. For example in Ghana, Accra Polytechnic, in collaboration with Aloha Medicinal USA, has developed a product called Immune Assist 24/7 from tropical *G. lucidum* and other mushroom species for enhancing the immunity of HIV/AIDS patients (Anchang, 2014).

Other biological properties of the mushrooms are antidiabetic, antioxidant, and antitumor (Meng *et al.*, 2016). Due to the benefits derived from mushroom production, many indigenous and commercial cultivation methods have been developed and put in place to domesticate mushrooms (Kortei *et al.*, 2018).

Mushroom cultivation has gained interest among entrepreneurs, farmers as well scientists around the world over the past few decades. Several studies reported various methods to make mushroom cultivation more profitable and popular while at the same time focusing on evaluating the source of nutrition for mushroom mycelium (Fasehah and Shah, 2017).

Alternatives for mushroom cultivation have been reported with varying success including empty fruit bunch of oil palm, wheat straw, cottonseed straw, cereal straw, corncob, sugar cane straw, and sawdust. (Masevhe *et al.*, 2016). According to Nithyatharani *et al.* (2018), a substrate is any material containing lignin, hemicellulose, and cellulose and where the mycelium can grow until it forms a fruiting body (mushroom). Suitable substrates for mushroom cultivation are important because substrates can influence nutritional content, yield, quality, efficiency, and economic costs as well influence cultivation time (Masevhe *et al.*, 2016).

Mushroom multiplication and survival are related to several factors such as chemical composition, the ratio of carbon (C) to nitrogen (N), sources of nitrogen, surfactant, minerals, pH, water activity, moisture, particle size, and amount of inoculum, antimicrobial agents, and the existence of interactions between microorganisms are considered as chemical, physical, and biological aspects that are linked to mushroom production (Bellettini *et al.*, 2019). The key environmental variables encompass luminosity, humidity, temperature, and air composition of the surrounding substrate, such as the concentration of carbon dioxide and oxygen, which affect the yield and quality of oyster mushrooms. (Mutema *et al.*, 2019).

The different artificial buffer agents used in mushroom cultivation are BisTris-HCL, BisTris-Citric acid, calcium carbonate, and MES-KOH. Nagahashi *et al.* (2006) reported some effects on hyphae growth and branching caused by different buffering systems. Child *et al.* (2013) tested MES and EMTA on 16 different fungal strains finding significant differences in the response to the buffering agent among the strains). Natural buffering agents often used are extracts of banana or plantain pseudo stem and biochar of plants and animals which have shown incredible success in mushroom farming.

1.1. Aim and Objectives of the Study

This research work aimed at comparative studies of the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* performances and the objectives are:

- (i) To cultivate *Pleurotus ostreatus* on empty fruit bunch of oil palm with natural buffer (decay pseudostem of banana) and artificial buffer (agricultural lime).
- (ii) To cultivate *Pleurotus ostreatus* on an empty fruit bunch of oil palm with an artificial buffer (agricultural lime).
- (iii) To cultivate *Ganoderma* on empty fruit bunch of oil palm with natural buffer (decay pseudostem of banana)
- (iv) To cultivate *Ganoderma* on empty fruit bunch of oil palm with artificial buffer
- (v) (agricultural lime).
- (vi) To compare the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* growth.
- (vii) To make recommendations based on the results obtained.

2.0. MATERIALS AND METHODS

2.1. Materials

Pleurotus and *Ganoderma* cultivation required the following: spawn, potato dextrose agar, weighing balance, spawn polythene bag, rubber band, cotton wool, methylated spirit, guinea corn, pieces

of foam, ½ inch pipes, bunsen burner, forceps, razor, extract of banana pseudostem, agricultural lime dissecting pins carried out at the National Cereal Research Institute at OwotUta, IbesikpoAsutan Local Government Area. The *Pleurotus* and *Ganoderma* were grown on empty fruit bunch of oil palm (an agricultural waste).

2.2. Mushrooms cultivation on Substrate/ Preparation

2.3. Collection and composting of substrate

Empty fruit bunch of oil palm (EFBOP) was obtained from a local oil palm processor and was packed to the research location. The EFBOP was macerated and ground using a fabricated grinder. It was then heaped and allowed to decay for one (1) month with the biweekly turning of the heap for aeration.

2.4. Bagging

A kilogram of the substrate was weighed into the mushroom heat-resistant polythene EFBOP to water ratio of 1kg: 10 ml. Using the ½ inch pipe, the polythene was closed and tight with rubber bands and stocked with pieces of foam.

2.5. Sterilization

The EFBOP stocked bags were packed into the autoclave and sterilized for 1 hour. It was then removed and allowed to cool for 24 hours.

2.6. Inoculation

The sterilized cooled substrate bags were inoculated with about 20g of spawn, tight, and stocked back aseptically for mycelial formation.

2.7. Incubation

The already inoculated bags were transported to a dark cool room with a regulated temperature of less than 25°C maintained throughout incubation. This takes about 4 weeks to complete mycelial formation. During the period of incubation, bags are checked for contamination, and subsequent removal was done if contaminated.

2.8. Fruiting

The appearance of white pin heads signifies readiness for the fruition of *Pleurotus* and *Ganoderma*. The bags are perforated to allow the sprouting of the matured mushroom. Daily watering of the bags was necessary to enhance the growth of mushrooms and maintain the moisture content of the baglogs. Checking of peat is done at this stage.

2.9. Harvesting

Harvesting of mushrooms was done manually by handpicking. Harvesting of mushrooms could last 2-3 months if maintained.

3.0 RESULTS AND DISCUSSION

3.1. Results

Comparative studies on the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* performances was carried out observing all microbiological standards. Data generated from the cultivation of *Pleurotus* and *Ganoderma* were studied and the following deductions were made. The results are presented in the Tables below;

3.2. Colonization rates of *Pleurotusostreatus* grown on natural and artificial buffered EFBOP

Comparative studies on the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* performances was carried out observing all microbiological standards. Data generated from the cultivation of *Pleurotus* and *Ganoderma* were studied and the following deductions were made. The results are presented in the Tables below;

Table 1: shows the colonization rates of *Pleurotusostreatus* grown on natural and artificial buffered EFBOP. The data revealed that natural buffered waste colonized faster than artificial buffered waste.

Table 1: Colonization rate of *Pleurotus* cultivated on natural and artificial buffered wastes of empty fruit bunch of oil palm (EFBOP)

VTreatments(Days)	7	14	21	28	35	42
T1 + PE(cm)	11.5	13.9	15.6	16.9	17.8	19.1
T2 + Al (cm)	7.2	9.9	12.1	14.8	15.4	17.1

T1 = 1kg EFBOP + spawn of *Pleurotus* + 100ml of DBPE

T2 = 1kg EFBOP + spawn of *Pleurotus* + 2% agric lime (Al)

3.3. Comparison of fruiting bodies of *Pleurotus* grown on natural and artificial buffered wastes of EFBOP

Table 2 shows the comparison of fruiting bodies of *Pleurotus* grown on natural and artificial buffered wastes of EFBOP. It was observed that *Pleurotus* grown on artificial buffered waste was better than the natural buffered waste.

Table 2: Comparison of fruiting bodies of *Pleurotus* grown on natural and artificial buffered wastes of empty fruit bunch of oil palm (EFBOP)

Treatments(weeks)	1 st Flush	2 nd Flush	3 rd Flush	Total
T1 + PE (kg)	184	307	500	991
T2 + Al (kg)	127	170	230	527

T1 = 1kg EFBOP + spawn of *Pleurotus* + 100ml of DBPE

T2 = 1kg EFBOP + spawn of *Pleurotus* + 2% agric lime (Al)

3.4. Colonization rate of *Ganoderma* on natural and artificial buffered wastes of EFBOP

Table 3 shows the colonization rate of *Ganoderma* on natural and artificial buffered wastes of EFBOP. It was observed that *Ganoderma* grew better in artificial buffered wastes than the natural buffered wastes of EFBOP.

Table 3: Colonization rate of *Ganoderma* grown on natural and artificial buffers on empty fruit bunch of oil palm (EFBOP) (cm)

Treatments(Days)	0	7	14	28	35	42
T1 + PE (cm)	0	0	4.3	9.8	11.8	18.6
T2 + Al (cm)	0	0	3.7	8.5	9.7	15.3

T1 = 1kg EFBOP + spawn of *Ganoderma* + 100ml of DBPE

T2 = 1kg EFBOP + spawn of *Ganoderma* + 2% of agric lime

3.5. Comparison of fruiting bodies of *Ganoderma* grown from natural and artificial buffered wastes of EFBOP

Table 4 shows the comparison of fruiting bodies of *Ganoderma* grown from natural and artificial buffered wastes of EFBOP. It was observed that *Ganoderma* had a slow growth rate and production rates.

Table 4: Comparison of fruiting body of *Ganoderma* grown on natural and artificial buffered wastes of EFBOP

Treatments(week)	1 st flush	2 nd flush	3 rd flush	Total
T1 + PE(kg)	0	3.0	5.0	8.0
T2 + Al (kg)	0	1.0	2.0	3.0

T1 = EFBOP + spawn of *Ganoderma* + 100ml of DBPE

T2 = EFBOP + spawn of *Ganoderma* + 2% agric lime

4.0. RECOMMENDATIONS

Based on the findings, the researcher wishes to recommend that;

Parents and other persons should prevent children from been labored as such do influence students academic performance in Biology.

5.0. CONCLUSION

Based on the findings, it was concluded that agricultural, hawking and domestic Comparative studies of the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* performances.

6.0. ACKNOWLEDGEMENTS

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An Expository Data Analysis of Student Teachers' Perception of Interest in Mathematics and Sciences in Uyo Educational Zone in Akwa Ibom State, Nigeria

***¹Esuong, U. U., ²Ibok, E. O. & ³Udo, O. F.**

^{*1,2&3}Department of Mathematics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

*Corresponding Author Email: uwaseesuong@gmail.com, Tel: +2348063274768

Abstract

Teaching practice is a compulsory training exercise undertaken by final year students in every College of Education in Nigeria. While in the field for the practice, the student teachers develop certain perception of students' interest in the classroom regarding mathematics and other science subjects. Thus, the paper ensures an interpretative analysis of the perception of these student teachers on the student's interest in mathematics compared with other science subjects. Seventy-one (71) student teachers of mathematics and other science courses in school of science of 2019/2020 academic session were involved in the study. The Mathematics and Science Students Interest Questionnaire (MSSIQ) was used for the collection of data, the data was analyzed descriptively using percentage. Findings of the study indicated that there is variation in the interest of students in mathematics and sciences. It is recommended that teachers should devise a means of inspiring student in the process of their teaching to enable them have interest in mathematics because of its relevance in their career later in life.

Keywords: Perception, Interest, Student-teachers, Mathematics performance

1.0. INTRODUCTION

Teaching practice refers to the preparation of student-teachers for teaching by practical training using teaching methods, teaching strategies, teaching principles, teaching techniques; and exercise of different activities of daily school life. "The term teaching practice embraces all the learning experience of student- teachers in schools". According to the Nigeria Commission for Colleges of Education (NCCE) guideline teaching practice exercise occupies a key position in the programme of teacher preparation. Perhaps, in order to improve the teaching profession in Nigeria, the National Universities Commission (NUC) in its Benchmark Minimum Academic Standards for undergraduate Programmes in Nigerian universities (2007) stipulates that all faculty of education students in the university should undergo a compulsory teaching practice exercise and it is a necessary condition for graduation. This is also stipulated in the Colleges of Education Minimum Academic Standards of the National Commission for Colleges of Education (NCCE) for students in the colleges of education (FGN 2006). "It provides a culminating experience in teacher preparation and also provides opportunity to student teachers to become socialized into the profession". Performance of teaching practice exercise provides basis for predicting the future success of the teacher. The entire process involved in teaching practice exercise is an important contributing factor towards the quality of teacher education programme. "During teaching practice exercise, interaction with students in the school provide a high degree of emotional stability within the student -teacher because such process of socialization enables the student -teacher to gain experience by linking to a culture of teaching and also feeling engaged, challenged and even empowered

". It should therefore be noted that going into teaching profession without undergoing teaching practice exercise could result in future poor performance (Ofonime, Esuong, & Enyekeme, 2018). Teaching effectiveness criteria involve content knowledge, knowledge about learners, lesson preparation and teaching methods as well as understanding learners' behaviours (Esuong and Enyekeme 2022). Student-teachers gain various experiences in schools with different resulting assumptions about teachers' role such as abilities, methods and qualities.

However, during teaching practice Students tend to have varying opinion regarding mathematics and sciences. These differences range from subject performance in mathematics, attention accorded to the subjects when they are being taught by their respective teachers, performance in the subjects in the examination, behavior towards the teachers taking mathematics and other sciences and how students view the teaching of mathematics and other sciences.

This study is important because of what Ekwueme (2013) described mathematics to be, as the subject area that is proven to be imperative for society in terms of progress and success whereby it's importance for students to have a deeper understanding of the concepts of these subjects in the beginning of their education.

However, Nyamba and Mwajombe (2012) citing Francis (2000) on subject preference of students referred to it as liking, interest or wants on something or as the real or imagined choice between alternatives and the possibility of rank ordering of these alternatives. In this respect, students at secondary school are confronted with mathematics and other science subject to study, whereby the former is most often considered difficult that latter (Esuong. U. U., Udom U.D. & Udo. O. F., 2019). Hence, the need to find out the preferences of students in mathematics has become necessary. It is against the backdrop that the study was conducted to actually have an interpretative analysis of students teachers' perception of students interest in mathematics in Uyo education zone in Akwa Ibom State, Nigeria.

1.1. Statement of the Problem

The dwindling performance of students over the years in mathematics has become a major source of concern and attention for educationist all over the globe. Students teachers who have firsthand interaction with students as they learn the pedagogy of teaching school subjects used the opportunity to observe the interest of students in school subjects. Students' abilities are of different magnitude at a certain level of learning and they have various degrees of interest in mathematics and other sciences. While some are more inclined to learn mathematics, others are more inclined to learn other science subjects. This unhidden interest of students in mathematics is reflected in their attention and love for the subject which in turn affect their learning process and inculcation of the basic mathematics concepts. Going by the growing concern over the performance of students in mathematics by students teachers who have returned from the teaching practice exercise. this paper seeks to offer an investigative analysis into the perception of students teachers over the interest of students in mathematics and other science subjects.

1.2. Objectives of the Study

The following were the objectives of the study:

- (i) to determine student teachers' perception of student subject preference between Mathematics and Science;
- (ii) to determine student teachers' perception on the performance of students between Mathematics and other Science subjects;
- (iii) to determine students-teachers' perception on students' stereotyping of Mathematics teachers.

1.3. Research Questions

Based on the objectives of the study, the following research questions were generated:

- (i) What is the perception of student teachers on students' subject preference between Mathematics and other science subjects?
- (ii) What is the perception of student teachers on the performance of students between Mathematics and other science subjects?
- (iii) What is the perception of student teachers on students' stereotyping of their Mathematics and science teachers?

2.0. RESEARCH METHODOLOGY

2.1. Population of the Study

The population of the study includes all the three hundred level (300) School of Science students, College of Education Afaha Nsit. The students who offered, Biology, Chemistry, Mathematics and Physics as major teaching subjects were considered. The following table represents the distribution of student teachers according to teaching subjects.

Table 1: Students' Teachers' Population Distribution

S/N	Students' Teachers' Population Distribution		
1	Biology	31	31
2	Chemistry	19	19
3	Mathematics	13	13
4	Physics	08	08
Total	Fours (04)	71	71

Source: teaching practice office department of curriculum and teaching

The Table 1 above indicates that thirty one (31) students were posted to teach biology as their major teaching subject Nineteen (19) students were posted to teach chemistry as their major teaching subject. Thirteen (13) students were posted to teach mathematics as their major teaching subject and only eight (08) students were posted to teach physics as their major teaching subject. This brings the total number of students posted to seventy-one (71) and this formed the population for the study.

2.2. Research Design

The research design employed in the study was a descriptive survey design. In this type of design, participants answer questions administered through interviews or questionnaire (Hale, 2011). As such

questionnaires were designed and used for the study. Questions in the questionnaire were directed to the student teachers who are in direct contact with the students during their teaching practice programme.

2.3. Sample and Sampling Techniques

The sample drawn from the population of all students' teachers is the seventy-one (71) student teachers of science and mathematics.

2.4. Instrumentation

The instrument developed for the study is Mathematics and Science Students Interest (MSSI). The instrument was constructed with likert scale options of SA-Strongly Agree, A-Agree, SD-Strongly Disagree and D-Disagree. The instrument contained twelve items in which the student teachers ticked option from the scale provided.

3.0. RESULTS

3.1. Research question One (I)

What is the perception of student teachers on students' subject preference between mathematics and science?

Table 2: Perception of students' teachers on students' preference between mathematics and science

S/N	Items	No.	Agreed Freq. %	Disagreed	Freq. %
1	Students prefer mathematics to science.	71	20 28%	51	72%
2.	Students prefer science to mathematics	71	56 79%	15	21%
3.	Students tend to listen attentively in math's classthan in science class.	71	24 34%	47	66%
4.	Students tend to listen attentively in science classthan in math class.	71	44 62%	27	38%

In table 2 above, a total of seventy-one (71) frequency of response were obtain, out of which twenty equivalent to 28% agreed that students prefer mathematics to science and fifty-one (51) equivalent to 72% disagreed that students prefer mathematics to science. In this regard, it can be concluded that most students prefer to study science than mathematics. In the second item, fifty-six (56) student teachers, equivalent to 79% agreed that students prefer science to mathematics. Likewise, fifteen (15) which is equivalent to 21% disagreed that students prefer mathematics to science. On paying attention in teaching mathematics and science, twenty-four (24) student teachers, equivalent to 34% agreed that students tend

to listen attentively in mathematics class than in science class whereas forty-seven (47) student teachers, equivalent to 66% disagreed. Conversely, in the last item forty-four (44) student teachers, equivalent to 62% agreed while twenty-seven (27) student teachers, equivalent to 38% disagreed.

3.2. Research question Two (2)

What is the perception of student teachers on the performance of students between mathematics and science?

Table 3: Perception of students teachers on the performance of students between mathematics and sciences

S/N	Items	No.	AgreedFreq (%)	DisagreedFreq(%)
	Students perform better in maths than science.	71	30 42%	41 58%
2.	Students perform better in science than maths.	71	45 63%	26 37%

Research Field work

Table 3 above shows a total of seventy one frequency of response were observed. Thirty student teachers, equivalent to 42% agreed that students perform better in mathematics than in science but forty one student teachers which is equivalent to 58% of them disagreed that students perform better in mathematics than in science; conversely forty five student teachers. Equivalent to 63% agreed that students perform better in science than in mathematics while only twenty six of them, equivalent to 37% disagreed that students perform better in science than mathematics.

3.3. Research question three (3)

What is the perception of student teachers on students' stereotyping of their mathematics and science teachers?

Table 4: Perception of students' teachers on students stereotyping of their Mathematics and science teachers

S/N	Items	No.	AgreedFreq.	DisagreedFreq.
1	Because I am a female teacher, students do not want to learn Maths from me.	71	10 14%	61 86%
2.	Because I am a female teacher, students do not want to learn science from me.	71	23 32%	48 68%
3.	Because I am a male teacher, student do not want to learn Maths from me.	71	05 7%	66 93%

4.	Because I am a male teacher, student do not want to learn science from me.	71	01	1%	70	99%
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Research Field Work.

In table 4 above, ten student teachers, equivalent to 14% agreed that because a teacher is a female teacher, students do not want to learn mathematics from them while sixty-one student teachers, equivalent to 86% disagreed with such opinion that because a teacher is female students do not want to learn mathematics from them. Similarly, twenty three student teachers, equivalent to 32% agreed that because a teacher is female, students do not want to learn science from them while forty eight student teachers, equivalent to 68% disagreed that because a teacher is female, students do not want to learn science from them. However, only five student teachers. Equivalent to 7% agreed that because a teacher is male students do not want to learn mathematics from them while sixty six student teachers equivalent to 93% disagreed that a teacher is a male students do not want to learn mathematics from them. Similarly, one student teacher, equivalent to 1% agreed that because a teacher is male, students do not want to learn science from them while seventy student teachers, equivalent to 99% disagreed that because a teacher is male not want to learn science from them.

4.0. DISCUSSION

The findings of the study in research question one revealed that students prefer science to mathematics because mathematics is difficult to learn compared to science. As such in teaching both areas, student tend to listen better when they are being taught science than when it is mathematics. This result corroborated with Nyamba and Mwajombe (2012) citing Francis (2000) on subject preference of students which is referred to as the liking, interest or wants on something or as the real or imagined choice between alternatives and the possibility of rank ordering of these alternatives. In this respect, students at secondary school are confronted with mathematics and other science subject to study, whereby the former is most often considered difficult than the latter which probably informed their choices.

In research question two, the findings was found in terms of performance, which showed that students perform better in science than mathematics. This is in line with the assertion of Esuong, Udom, & Udo, (2019) who agreed that students often perceive mathematics as an abstract subject. Hence, the need to find out the preferences of students in mathematics has become necessary.

In research question three, gender was found to play a role in teaching mathematics and science, whereby regardless of teachers' gender mathematics could be learnt from the teacher.

5.0. RECOMMENDATIONS

- (i) Students should always be enlightened that mathematics is the queen of science which if not properly rooted in mind right from the beginning the learning of other subjects becomes difficult.
- (ii) Government should strive to provide more instructional materials that will enable teachers to enrich their instructional process so as to secure the attention and interest of the students from the beginning of the lesson through the end.
- (iii) Mathematics lesson should be brief and concise (but not long) at the early stages of the child's schooling through supervision by the school authorities at regular intervals.

- (iv) Teachers should improvise teaching aids where necessary.
- (v) Teachers should exhibit a moderate behavior during instruction so that gender stereotyping is not built up in the minds of the students.
- (vi) Most mathematics lessons should be students centered in order to attract students' interest and attention during these periods.
- (vii) Teachers should devise a means of inspiring their students the print of mathematics through their instruction.

6.0. CONCLUSION

The study highlights the interest of students in mathematics and science with a specific reference to subject preference, students' behaviour towards their teachers when they are teaching them, and whether or not students learn better when taught by a particular gender. The study also looks into the issue of students' performance in mathematics and science. The subjects of the study were the teaching practice students of Akwa Ibom State College of Education Afaha Nsit. Finally the study revealed that students in secondary schools in akwa ibom state prefer science to mathematics and tend to be attentive in science class than in mathematics class.

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An Empirical Analysis of the Conditional Cash Transfer (CCT) Programme and the Welfare of Uruan Local Government Area of Akwa Ibom State

¹Ettah, B. E., ^{*2}Akpan, O. M. & ³Udo, E. G.

¹Department of Economics, Faculty of Social Sciences University of Uyo, Uyo, Nigeria

^{*2&3}Department of Economics, School of Arts and Social Sciences, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria

^{*}Corresponding Author Email: ofonadolf@gmail.com, Tel: +2349076800328

Abstract

The Conditional Cash Transfer (CCT) program is one of the social investment programme introduced to alleviate the level of poverty in Nigeria. By delivering social services in form of income to the vulnerable and those in extreme poverty. This study sought to examine the effect of the Conditional Cash Transfer programme on the welfare of beneficiaries in Uruan L.G.A of Akwa Ibom State, using descriptive survey design. The population of the study comprises all the twenty- nine thousand one hundred and seventeen (29,117) beneficiaries from the nine pilot Local Government Area of the programme Akwa Ibom State. Three hundred and fifty-four respondents (354) constituted the sample size for the study drawn from the study area, determined using Yaro Yamme formula. The data for the study was collected primarily with the aid of a structured questionnaire, together with observation and interviews scheduled. The findings of

the study are that the advent of conditional cash transfer programme in Uruan L.G.A of Akwa Ibom State. Has led to the;Increased in the number of savings groups,Increased in the amount of income saved in the bank by indigenes,Increased the number of cooperative societies,Increased in the number of businesses established as well as Increased in number of individuals acquiring asset in Uruan L.G.A,the study thus concludes that the advent of the conditional cash transfer programmes (CCT) has helped improve the welfare of the indigenes of Uruan L.G.A. and recommends thatNew beneficiaries should be enrolled into the programme by the federal government, so that the benefits of the CCT programme be enjoyed by all and that the State cash transfer unit should ensure that the beneficiaries be adequately supervised to ensure that the transferred funds be used as prescribed.

Keywords: Conditional Cash Transfer, Level of poverty, Social investment programme, Welfare, Uruan Local Government Area, Akwa Ibom State

1.0. INTRODUCTION

Conditional cash transfer (CCT) program is a new type of social assistance program that represents an innovative approach to the delivery of social services especially to the vulnerable and those in extreme poverty (Rawlings, 2004). The programme was introduced in Nigeria in 2016, by President Buhari's administration as one of the social investment programme, and also as part of the federal Government of Nigeria's larger growth and social inclusion strategies aimed at addressing key social concerns in the country.

The basic idea of CCT is that incentives given to households are to keep their children in school and diligently check their health (Ravallion, 2016). However, this strict requirement is seen by critics as a form of paternalism because it ignores poor people's ability to identify the real needs of their families. On the other hand, CCT proponents believe that households remain poor because parents do not give children the right to obtain an adequate education. Instead, they prioritize helping their families meet life's necessities (Ravallion, 2016). Studies on the effectiveness of CCT show a weakness in targeting or directed marketing. Initially, targeting suppressed program leakage due to incorrectly focused target groups (Ravallion, 2016). However, targeting has weaknesses, such as biases in determining target groups which is more profitable by local elites, and in determining poverty lines to choose the target groups. Mirrlees (1971) highlighted these weaknesses regarding trade-offs between equity and efficiency of administrative capacity (Ravallion, 2016). Equity refers to the right of all poor people to fulfill their needs. In contrast, efficiency refers to the government strategy that prioritizes target groups due to limited resources.

1.1. An Overview of Conditional Cash Transfer (CCT) Programme in Nigeria

The programme was introduced in Nigeria in 2016, by President Buhari's administration as one of the social investment programme, and also as part of the federal Government of Nigeria's larger growth and social inclusion strategies aimed at addressing key social concerns in the country

The programme which is also known as Household Uplifting Programme (HUP),which is under the National Social Safety Nets Project (NASSP) in Nigeria is coordinated by the National Social Safety Nets Coordinating Office (NASSCO) and designed to be implemented by National Cash Transfer Office, has partnered with the World Bank.

The Project objectives is to provide access to targeted transfers for Poor and Vulnerable Households (PVHHs) under an expanded national social safety nets system. The programme is termed cash plus because in addition to the cash benefit, the capacity of the members of Poor and Vulnerable Households (PVHHs) are strengthened to enabled them break generational poverty cycle and aim to:

- (i) Improve Household (HH) consumption
- (ii) Increased in utilization of health and nutrition services
- (iii) Improve school enrolment and attendance
- (iv) Improve environmental sanitation and management
- (v) Enhanced household asset acquisition
- (vi) Encourage beneficiaries to engage in sustainable livelihoods.

The programme is called conditional cash transfer because there are some criteria which the Poor and Vulnerable Households (PVHHs) have to meet before cash transferred is made, they include;

Enrolment of children into public schools, getting regular check-ups at the doctor's office and receiving vaccinations. The programme has three components which includes; Based Cash Transfer, Top -up based on state selected condition and Livelihood Support. The programme has key officers which are;

1.2. Cash Transfer Facilitators (CTFs) -These are mostly local government workers, recruited by the programme national officials, and assigned local government Area, whose main task are to mobilize the community, with the support of its leadership, sensitize beneficiaries and capture data of caregivers and alternate caregiver.

1.3. Desk Officers(Dos) - These are also local government workers that are recruited by the programme national officials and sent to different Local Government Area to organize data collected in their assigned local government area, they also supervise in the field, all CTFs in that LGA. They Dos also communicate to the SCTU/MIS officers on logistics and to obtain location list for data collection.

1.4. Management Information System Specialist (MISS) Officers -These are recruited state workers that are saddled with the responsibilities of data organization in their state, monitor field activities throughout the state, training of CTFs on enrolment process, and Household information update, proper documentation of allocation of mobile devices and work tools to LGAs, Collation and analysis of comprehensive report on enrolment, Programme identity card production, Programme identity card distribution etc.

Unlike every state in Nigeria, the programme was introduced in Akwa Ibom State in 2018, with its commencement in nine (9) local government as pilot Local government Areas, of which Uruan Local Government Area was inclusive.

It is observed that the welfare of the people of Uruanhas improved over the past five (5) years, many seems to attribute it to the advent of the conditional Cash Transfer Programme. It is on this basis that this study seeks to investigate the effect of Conditional Cash Transfer programme on the welfare of beneficiaries in Uruan LGA of Akwa Ibom State in Nigeria. It specifically seeks to;

Examine how the advent of CCT Programme has led to;

- (i) Registration of members into multipurpose cooperative societies in Uruan LGA
- (ii) Facilitate proper account keeping /savings of the transferred funds by beneficiaries in Uruan LGA
- (iii) Engagement in trade by beneficiaries in Uruan LGA
- (iv) Creation of source of business financing for beneficiaries in Uruan LGA.

This research is anchored on the “Big Push” theoretical framework which provides the theoretical basis and philosophy of grants as a means to push families out of extreme poverty and achieve development.

Similar researches have been carried out by various authors in various locations to ascertain the effect of Conditional Cash Transfer on the poor and vulnerable. Such researches include that of;

Useni (2011) who sought to know if differential exposure to conditional cash transfer programme on vulnerable people affects labour market outcome. The result reveals that it does affect labour market outcome.

In another study carried out by Seyram and Evans (2015) to examine how much conditional cash transfer performs and its impact on vulnerable households in Nigeria, of which the study employed a longitudinal correlation design. The result of the findings was that conditional cash transfer has a little or no effect on poverty alleviation of vulnerable people in Nigeria.

Parker and Vogt (2018) also employed panel regression analysis in the examination of the relationship between poverty alleviation and welfare of vulnerable people in United States of America, of which they found out that there exist a significant relationship between poverty alleviation and welfare of vulnerable people in USA.

Saucedo Delgado et al. (2018) used a longitudinal data on their evaluation of the impact of CCT on the use of public services of households in Mexico by employing Propensity Score Matching (PSM) in estimating ATT for their analysis. They found out that the program has a short-term impact on households’ demand for health and educational services, however the effect varies in the long-term.

Similarly, a study conducted in 2012 by Meng and Pfau concluded that targeting the poor children as the beneficiaries of CCT would have the largest impact. The study suggested that even with limited budget, targeting all poor children in ten poorest provinces will lead to a significant reduction of poverty

Han et al. (2016) investigated the effect of Dibaao, which is China’s largest social assistance program, on its beneficiaries’ spending in rural using PSM method and their study revealed that the program has a positive impact on the health spending, but no effect on their food and education expenditure. A prioritized health spending over education was attributed to a wide gap of real returns to schooling between rural and urban areas in China.

An impact evaluation of CCT in Philippines during its early stage of implementation was conducted by Chaudhury et al. (2013). They revealed that CCT program is significant in changing the spending pattern of the households as more spending on education and health were observed, however no impact on aggregate consumption of households. An increase also in savings among beneficiary households was found in their paper, in which they suggested that it can be attributed to the less

consumption of households to some adult goods like alcohol. Moreover, they concluded a noticeable difference of the impact of CCT by province

A study by Tutor (2014) on the short-term impact of CCT in the Philippines on consumption showed a significant positive impact in terms of expenditure shares on spending on education and clothing by 0.1 and 0.5 percentage points respectively. Furthermore, Tutor (2014) asserted that the effect of CCT on consumption is most evident among the poorest households due to the income-reducing effect. These households are more likely to comply with the conditions set by the program.

From the review of some related works to this study, none was seen to examined the effect of conditional cash transfer programme and the welfare of Uruan people of Akwa Ibom State in Nigeria. Thusthis study intends to fill the gap, and also add to existing literature in the study area.

2.0. RESEARCH METHODOLOGY

2.1. Research Design: This study used descriptive survey design

Area of the Study: The area of the study was Uruan Local Government Area of Akwa Ibom State, one of the pilot Local Government Areas, chosen for the programme. The Local Government Area has eleven(11) wards and (fifty) 50 villages. However, the programme was carried out in eight (8) wards of the Local Government Area, which were; Central Uruan 1 with the total beneficiaries of three hundred and seventy-three(373), Central Uruan2 with five hundred and thirty-two(532),Central Uruan3 with one thousand one hundred and fifty-three(1153), Northern Uruan 1 with one thousand two hundred and forty(1240), Northern Uruan2 with twenty -seven(27), Southern Uruan 1 with seventy-five (75),Southern Uruan2 with one hundred and twelve (112) and Southern Uruan 111 with thirty-two(32) beneficiaries summing the total beneficiaries to three thousand five hundred and thirty five(3535) beneficiaries of the programme.

2.2. Population of the Study: The population of the study comprises all the twenty- nine thousand one hundred and seventeen (29117) beneficiaries from the nine pilot Local Government Area of the programme in Akwa Ibom State.

2.3. Sample and Sampling Technique: The sample size for this study was Three hundred and fifty-four respondents (354) drawn from the study area, which was determined using Yaro Yamme formula.

The data for the study was collected primarily with the aid of a structured questionnaire, observation and interviews.

2.4. Activities Carried Out By Conditional Cash Transfer (CCT) Programme

The activities undertaken by the programme commences from mining of the beneficiaries names from the National Social Register (NSR) comprising State Social Registers of poor and vulnerable households. The eligibility cut-off criteria for Cash Transfer Programme which is the absolute poverty line corresponds to the 1st to 6th decile of the National Social Register (NSR). The poor and vulnerable Households that falls within the 1st to 6th decile of the NSR distribution are considered eligible for conditional cash transfer.

The list contains the following information;

- (i) Location Details: Geo-political zone, State, LGA, Ward, Community Type (Rural/Urban)
- (ii) Household Detail; Household number, Head of Household Name, Household Address, Proximity to Health care.
- (iii) Household Members Details: NSR Ref. Number, Names, Gender, Age, Marital Status, work Types, Education, Disability. Etc
- (iv) Household Labour Markets Characteristics
- (v) Household Members's Education, health and Disability information
- (vi) Household Assets
- (vii) Household living /dwelling characteristics.
- (viii) Enrolment process; afterwards the beneficiaries are considered eligible according to the stated conditions, they are then enrolled into the programme. The enrolment process includes;

1. Poor and vulnerable households list disaggregated by States, LGAs, Wards and Communities

2. Production of two copies of PVHHs list on A2 paper per community for disclosure at the communities during community sensitization on CCT Programme and one copy per household caregiver/alternate forms to guide CTFs during enrolment.

3. Training of CTFs on beneficiaries' enrolment process including use of mobile application for identification of Caregivers/alternates and capturing of their additional information for 2 days.

4. Configuration of mobile application and loading of data of beneficiaries' household per Ward 2 days

5. Community mobilization visit by CTFs with the support of community leadership for average of 3 days per wards

6. Community Stakeholders sensitization on CCT Programme and beneficiaries' households list disclosure in the communities for community validation for average of 3 days per ward

7. Beneficiary households' orientation on programme objectives and their responsibilities, caregiver and alternate caregiver selection and data capture in the community for average of 6 day per ward

8. Upload of data from mobile devices to NCTO server

9. Production of programme identity cards with QR code and digital passport photographs of caregivers and Alternates

10. Distribution of programme identity cards to beneficiaries by CTFs for 2 days
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After the distribution of identity cards to the beneficiaries, payment is then done to the beneficiaries on announced date and venue and identity cards are shown to the payment officers before payment is made. The cash transfer of five thousand naira #5,000 is to be made to beneficiaries monthly.

Subsequently, when these funds are received by the beneficiaries, they are encouraged by the Cash Transfer Facilitators (CTFs) to belong to multipurpose cooperative societies. Their registration into these cooperative groups enables them to;

- Save part of the transferred funds for future use as a group.
- Engage in cooperate trade, such as buying of food items like crayfish, fish in bulk and sharing to members for sale.
- Engaging in cooperate animal farming such as pig, poultry, snail etc.

2.5. An Analysis of Conditional Cash Transfer Programme and Welfare of Uruan Local Government Area

There are indicators to how the welfare of the people of Uruan were before now, the indicators are;

The formation groups/registration of Multipurpose Cooperative Society. How was this beneficial to member vis a vis the beneficiary in Uruan in terms of economic activities in the groups. Such activities include loans given to members to boost their individual businesses, how many collected and how many refunded such loan

- (i) What type of business/economic activities were these Cooperative societies engaged in?
- (ii) Were there benefits accrued to them. What did they make of these benefits, if any
- (iii) Were they (i.e. MPCS and beneficiaries) financially included. That is, able to keep proper account recording including having bank account. How many were able/not able to contribute to group savings
- (iv) Were they also able to acquire Assets? What were these assets and how effective and beneficial were these assets to their business.
- (v) Overall contribution of above to the CCT in Uruan L.G.A

2.6. Total Number of Beneficiaries

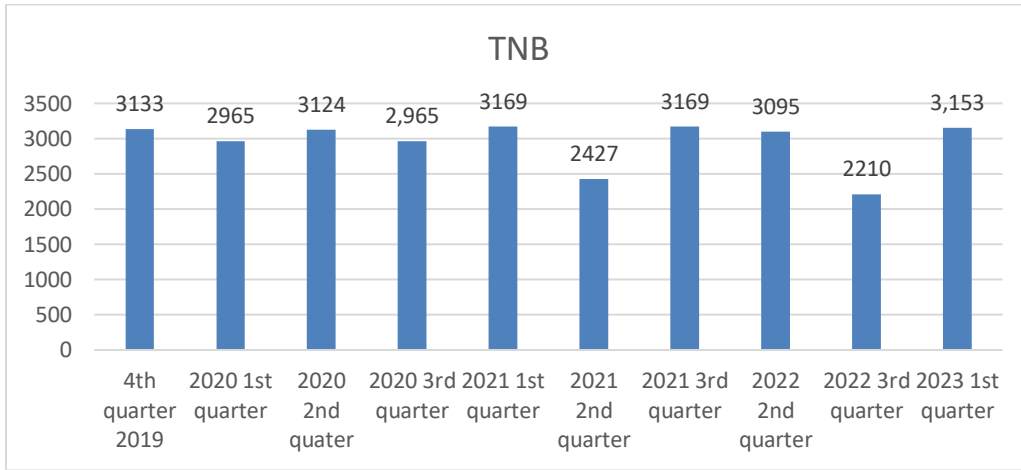


Figure 1: shows that the total number of beneficiaries in the conditional cash transfer programme in Uraun L.G.A increased between the 1ST quarter of 2021,3rd quarter of 2021,1st quarter of 2023 as well as 1st quarter of 2020.

2.7. Total Number of Savings groups mobilized

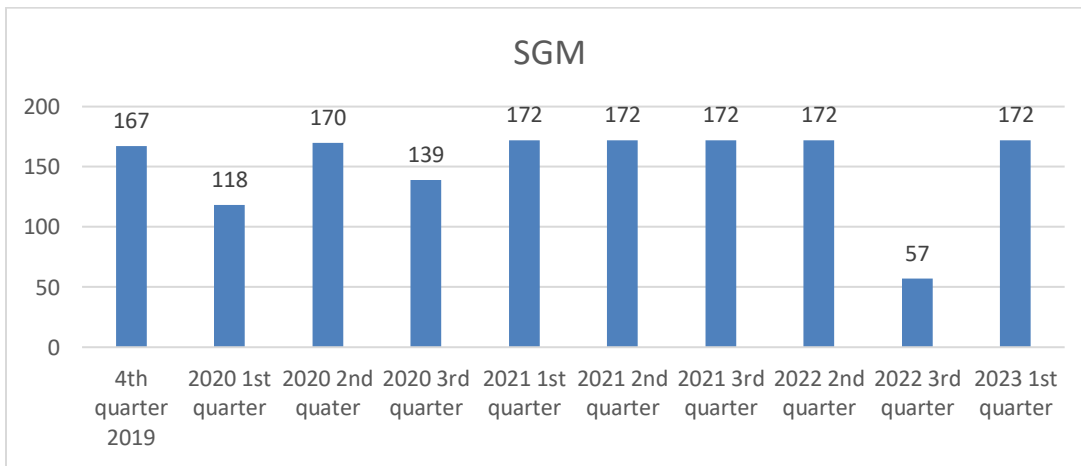


Figure 2: shows that the total number of savings groups mobilized through the conditional cash transfer programme in Uraun L.G.A increased between the 1ST quarter of 2021,3rd quarter of 2021,1st quarter of 2023, 1st quarter of 2020 as well as 4th quarter of 2019.

Total Number of Cooperatives Societies

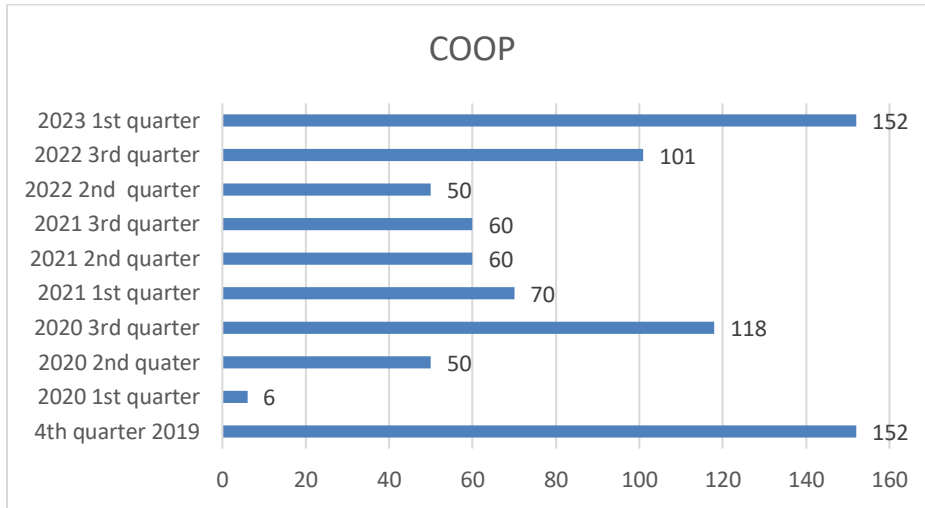


Figure 3: shows that the total number of cooperatives societies formed through the conditional cash transfer programme in Uraun L.G.A increased in the 1ST quarter of 2023, 3rd quarter of 2022, 3rd quarter of 2020, as well as 4th quarter of 2019.

2.8. Number of Savings at Hand

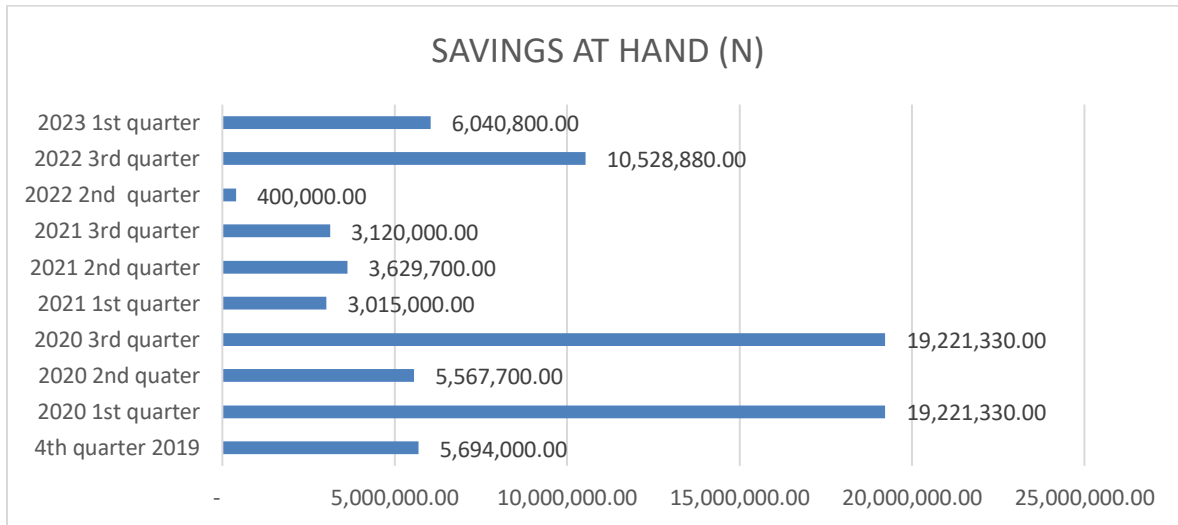


Figure 4: shows that the number of savings at hand through the conditional cash transfer programme in Uraun L.G.A increased significantly in the 3rd and 1st quarter of 2020 respectively, 3rd quarter of 2022 and in the 3rd quarter of 2022 as well.

2.9. Number of Savings at bank

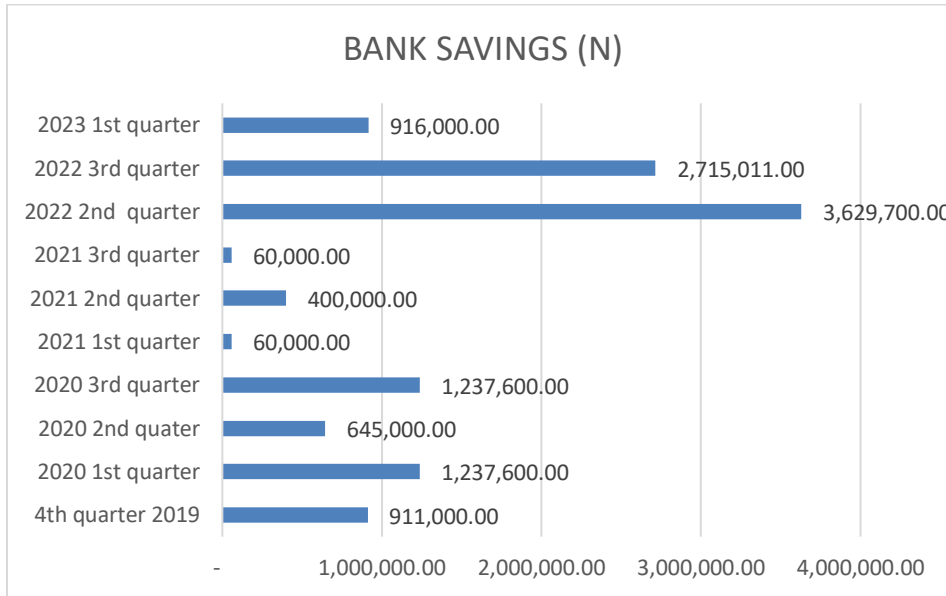


Figure 5: shows that the number of savings at hand through the conditional cash transfer programme in Uraun L.G.A increased significantly in the 2nd and 3rd quarter of 2022 respectively, and as well as 3rd quarter of 2020.

2.10. Number of Businesses Established

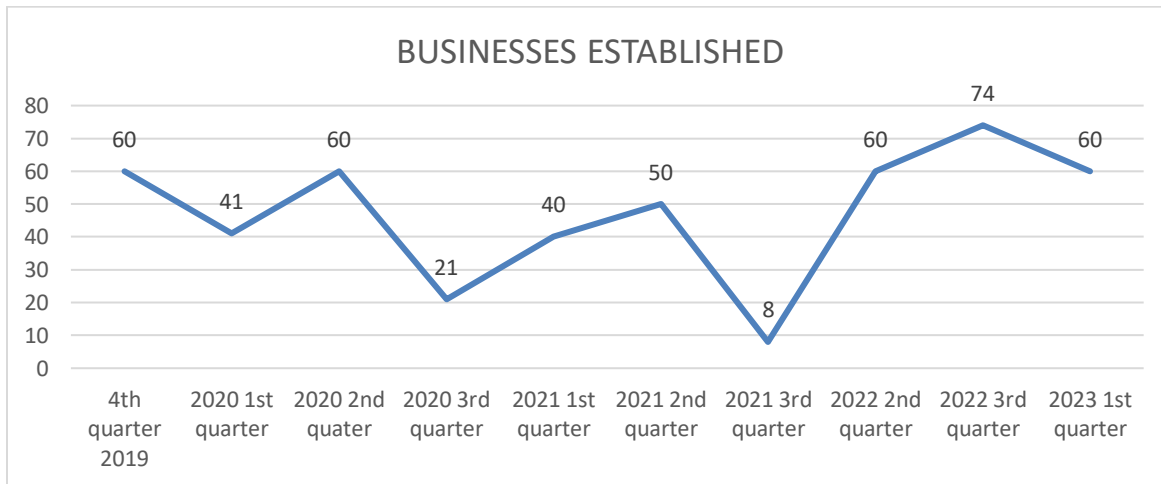


Figure 6: shows that the number of businesses established through the conditional cash transfer programme in Uraun L.G.A increased significantly in the 3rd quarter of 2022 and 1st quarter of 2023 respectively.

Analysis of Asset acquired.

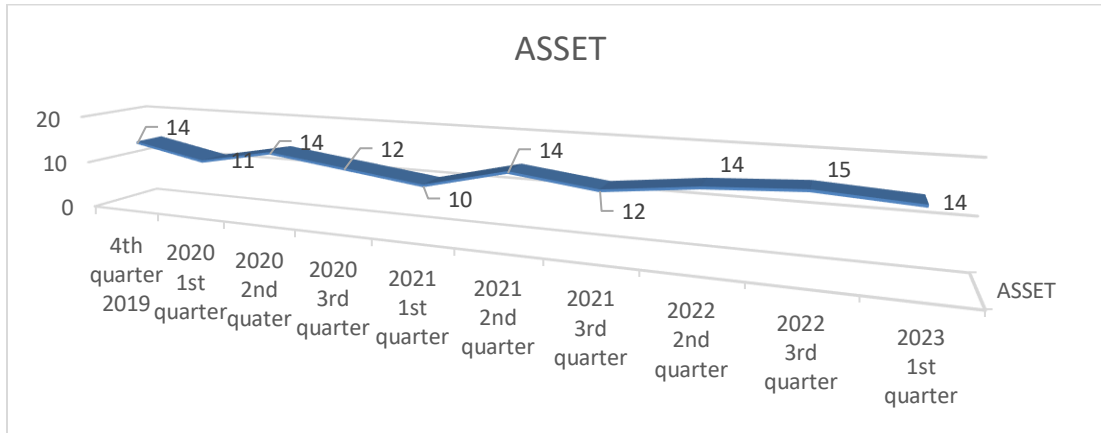


Figure 7: shows that the number of assets acquired through the conditional cash transfer programme in Uraun L.G.A increased significantly in the 4th quarter of 2019, 2nd quarter of 2020, 2nd quarter of 2021 as well as 3rd quarter of 2022.

3.0. SUMMARY

The findings of the study are that the advent of conditional cash transfer programme in Uraun L.G.A of Akwa Ibom State. Has led to the;

- (i) Increased in the number of savings groups in Uruan L.G.A
- (ii) Increased in the amount of income saved in the bank by indigenes of Uruan L.G.A
- (iii) Increased the number of cooperative societies in uruan L.G.A
- (iv) Increased in the number of businesses established in Uruan L.G.A
- (v) Increased in number of individual acquiring asset in Uruan L.G.A

Based on the findings, the study thus concludes that the advent of the conditional cash transfer programmes (CCT) has helped improve the welfare of the indigenes of Uruan L.G.A

4.0. RECOMMENDATIONS

Based on the findings of the study, it is recommended that;

- (i) New beneficiaries should be enrolled into the programme by the federal government, so that the benefits of the CCT programme be enjoyed by all.
- (ii) The State cash transfer unit should ensure that the beneficiaries be adequately supervised to ensure that the transferred funds be used as prescribed.

5.0. ACKNOWLEDGEMENTS

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Teachers' Quality and Academic Performance of Physics Students in Public Secondary Schools in Uyo Local Government Area, Akwa Ibom State

¹Eyenaka, F. D., ²John, D. E. & ^{*3}Dan, N. E.

^{1,2&*3}Department of Physics, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria.

*Corresponding Author Email: nsikand8@gmail.com, Tel: +2348109733861

Abstract

This study investigated the influence of teachers' quality on students' academic performance in Physics in Uyo Local Government Area. Four research questions were raised. The research design adopted was correlational design. The population of the study comprised the 36 Physics teachers in the 14 public secondary schools in Uyo Local Government Area of Akwa Ibom State. The sample of the study was 36 Physics Teachers and 6838 senior secondary one students. "Teachers' Quality Scale (TQS)" and the "Students' Academic Performance Checklist (SAPC)" were used for data collection. The instruments were validated and tested for reliability. Data analysis was done using mean scores for answering research questions raised. The results indicate that majority of Physics teachers in the study area had only first degree (72.2%), indicating lack of career development; had less than ten years of experience (61.1%), indicating absent of mentorship; and lack requisite professionalism (66.7%). The findings of the study revealed that students' academic performance in Physics differs based on teachers' years of experience, teachers' educational qualification, and teachers' professionalism in Uyo Local Government Area. It is concluded that teachers that graduated from education, those with highest qualifications (Doctorate), and those teachers with many years of experience significant influence students' academic performance in Physics than others in other cadres. It is recommended among others that Akwa Ibom State Government should design policy that would actively engage teachers, not only in teaching but equally in school administration; create avenues for workshops and seminars that are geared towards improving teachers' professionalism vis-à-vis teaching proficiency. This will enhance their efficiency in the coordination of assigned and statutory responsibilities in schools for quality assured educational service delivery.

Keywords: Teachers' quality, Academic performance, Working experience, Professionalism, Educational attainment

INTRODUCTION

The greatest investment for human development that has translational effect on the transformation of human society is education. Education has the potency to transform and configure human social, emotional, mental and psychological intelligence for a better informed individual that can contribute to self and societal development. The achievement of the goals of education depends greatly on the students' academic achievement. Fundamentally, students' academic achievements in sciences generally and Physics in particular become worrisome, considering its importance in the development of a nation.

Students' academic performance in Physics can determine the level of advancement in scientific base of any nation. This is because Physics is a basement of Science and its discoveries have continued to act as catalysts to technological advancement in the 21st century society. However, the fact that Physics is fundamental in the advancement of science development prompt the desire to investigating students' performance in the subject. According to the National Policy on Education (2016), academic excellence in Physics areas will provide high level skilled manpower who can apply the scientific knowledge to solve environmental problem, provide goods and services for the convenience of man. Sadly, review of studies such as Isola (2022) testified to poor performances of secondary school students in physics. This unimaginable level of failure in physics is understatement but worst hit are the major concepts embedded in the subject such as radioactivity, matter, upthrust, electricity and magnetism among others (Isola, 2022).

Basically, teaching has been argued as the most prominent determinant of the success or failure of any educational system. This is perhaps due to the fact that every curriculum instruction must be transferred to the learners using teaching process. Thus, teaching process is the prominent input variables require for the actualization of expected educational output. It could be said to function as a model structure that sustains the spark in the cognitive development process of a learner. Teaching involves bringing about or at least facilitating desirable changes in learners. This underscores the fact that teaching is the determinant of the success or failure of students academically. It facilitates easy interpretation of curriculum blueprint (instructions); determines the level of interest and retention command in students, as well as the general attainment of the aims of which it was design to achieve. In other words, teaching effectiveness is the type of teaching characterized by the exhibition of intellectual, social and emotional stability, love for children and positive disposition towards the teaching profession and ability to inspire good qualities in students.

Nevertheless, the quality of education outcome derived from Physics especially in secondary schools promote an intense doubt that the aims of the subject has been achieved. This is evident in issues of mass failure in the subject occasioned by the students' apathy, poor concentration, poor attendance, and poor retention. The current status quo as observed by the researcher may not be separated from teaching ineffectiveness, a situation which has bedeviled the school system making learning uninteresting; boring and highly dissatisfactory to students. More worrisome is the fact that most of the teaching approaches adopted in transferring Physics instructions are vague and discouraging students' retention on the subject. Although many factors have been attributed to these challenges, it is a researcher's view that teachers' quality could play a prominent role in determining the extent of effectiveness or ineffectiveness in achieving Physics curriculum goals in secondary schools. This is premised on the fact that teachers are the transformers, moulders and designers of learners' skills and attitudes.

According to Afe (2021), teachers hold the key to their own teaching by playing crucial roles in educational attainment. The teacher is ultimately responsible for translating policy into action and principles based on practice during interaction with the students. They help the students to decide on what to learn, and how to learn. Teachers develop appropriate learning units, establish functional classroom cultures, effectively organize and manage classroom planning. They deliver focused, structural and engaging lesson as well as communicate clearly, the curriculum instructions to their students. These broaden the potentials of teachers as the machinery on which everything in school system is based.

Teachers' qualities are what qualify the teachers as persons responsible for the translation of curriculum instructions. They are the variables that distinguish two or more teachers uniquely. It includes both teacher qualifications and characteristics (input) that influence teachers' instruction (process) and

students' outcomes (example achievement and motivation) (Akinyemi, *et.al.*, 2017).). Some of the teachers' quality as considered in this study are: teachers' educational qualification, years of working experience, and professionalism.

Teacher's qualification determines the level of educational attainment of a teacher. It has been argued that teachers' qualification has remarkable effect on their teaching effectiveness (Bett, Zau and Rice, 2003; Goldhaber and Brewer, 2000). On a contrary, Nilsen (2022) inferred that educational qualification of a teacher does not have significant effect on teacher's teaching effectiveness. However, this contradictory position of scholars informs the researcher's contemplation to assess whether teacher's qualification could really be responsible for the current state of teaching ineffectiveness as could be seen in the relatively poor academic performance of students in Physics in secondary schools. Another variable of teachers' quality that could have significant influence on teaching is the teachers' years of working experience. Effiong (2017) considers teacher's years of experience as the numbers of years a teacher puts in doing the teaching engagements. One could argue that the more an individual is on a particular job/task, the more efficient, proficient and passionate he/she might tend to be. This argument might either be true or false depending on if other essential variables that make working environment interesting are available or not available. Ololube (2018) maintained that teacher's years of experience has significant influence on their job performance and job satisfaction. Whether this is applicable to Physics is the concern for the study.

Teachers' professionalism is equally a vital aspect of teacher's quality that has a tendency to influence their obligatory effectiveness and efficiency. Ololube (2018) explains that a professional teacher is a teacher that acquired professional training that gives him/her professional knowledge, skills, technique, and aptitude required for effectiveness. It entails a teacher that possesses requisite expertise in any area of specialty including Physics. It is noteworthy to state that a professional Physics teacher has a requisite knowledge of the concepts in the curriculum that does not need much effort to promote his/her efficiency and effectiveness. However, a professional might not render effective service when other important school variables are lacking.

From the positions of scholars on the effect of teachers' quality as highlighted in the background, many scholars believed that teachers' quality have significant effect on teaching effectiveness while others reported no significant effect. Therefore, consensus has not been reached on this case coupled with the fact that no such study has been found that assess their relational effect with specific emphasis on Physics in Uyo Local Government Area. It is premised on this position that the basis of this study is formed.

Objectives of the Study

The objectives of the study were to:

- (i) Examine the differences in Physics teachers' quality in Uyo Local Government Area.
- (ii) Ascertain the difference in students' academic performance in Physics based on teachers' working experience in Uyo Local Government Area.
- (iii) Determine the difference in students' academic performance in Physics based on teachers' educational qualifications in Uyo Local Government Area.
- (iv) Determine the difference in students' academic performance in Physics based on teachers' professionalism in Uyo Local Government Area.

Research Questions

The following research questions were used:

- (i) What is the differences in Physics teachers' quality in Uyo Local Government Area?

- (ii) What is the difference in students' academic performance in Physics based on teachers' working experience in Uyo Local Government Area?
- (iii) What is the difference in students' academic performance in Physics based on teachers' educational qualifications in Uyo Local Government Area?
- (iv) What is the difference in students' academic performance in Physics based on teachers' professionalism in Uyo Local Government Area?

Review of Literature

Advances in physics often enable advances in new technologies. For example, advances in the understanding of electromagnetism and nuclear physics led directly to the development of new products that have dramatically transformed modern-day society (Akinyemi, *etal.*, 2017). As such, for Nigeria top development technologically, issues of students' academic performance in Physics must be holistically considered. Ujulu, Abah, Kilian and Hikon (2019) explained academic performance of students as a yardstick for education itself. It is the indices for testing educational quality and thus is a challenge to schools to aspire to maintain a high level performance in internal and mostly external examinations. Put differently, Cohen, Manion and Morrison (2011) refers to students' academic performance as qualified by measure of students' academic standing in relation to same age bracket. The optimization of students' academic performance in Physics depends greatly on the teachers' quality. Teacher quality such as qualification, professionalism, confidence, motivation and experience may be contributing factors to their output. For instance, Ujulu, Abah, Kilian and Hikon (2019) investigated the influence of teacher's quality on student's academic achievements in secondary schools in Jalingo Local Government Area of Taraba State. It was found that majority of secondary schools' teachers in Jalingo were professionally qualified. But their teaching was not effective.

The professionalism of a teacher is a process that has to do with teachers adhering to the code of conducts guiding the teaching profession. Basically, two categories of teachers are employed in Nigeria. That is, teachers who are academically qualified and those that are professionally qualified to carry out instruction in the classroom. By academically qualified (non-professional) teachers, it means teachers who have academic training without professional teacher training as a result of enrolment into institution of higher learning to obtain qualifications that can enable them gain lucrative employment. While professionally qualified teachers, are teachers who get professional teacher training that gives them professional knowledge, skills, techniques, aptitude as different from the general education. According to Fehintola (2014), in a typical classroom setting, a professional teacher demonstrates excellent attitudes in his or her teaching better than non-professional teacher. Professionalism of a teacher has influence on a lot of variables such as student motivation, teaching methodologies, communication skills, organization of content and planning of lessons, students' participation during lessons, teacher confidence and knowledge of subject matter (Maende, 2012). Nabukenya (2007) opined that teacher professionalism affects the role of the teacher and his or her pedagogy, which in turn affects the students' ability to learn effectively.

Akinyemi, Shittu, Faduyile and Orunbon (2017) emphasized that teachers' professional traits are key predictors of improved students' academic performance. This according to the authors emanates from the fact that professionalism provides teachers with adequate knowledge of the subject and significant enablement to coordinate the classrooms environment for effective teaching. Zhaohui and Anning (2020) asserted that teacher professionalism improved teachers' research abilities and instructional methods and in turn, improved students' outcome significantly. This is similar to that of Oshinyadi (2020) and Akinyemi, *etal.*, (2017) which amongst others, a positive correlation between teacher preparation and

students' academic performance, teacher professional development and students' academic performance and a significant impact of teacher preparation pathways on students' academic performance scores. It was concluded that teachers with at least postgraduate diploma in education (PGDE) have the most significant impact on students' academic performance.

Qualification is also one of the critical factors that drive students' academic performance (Kola et al., 2015). Merriam - Webster Dictionary defines 'qualification' as a special skill or type of experience or knowledge that makes someone suitable to do a particular job or activity. Teachers' qualifications could, therefore, mean all the skills a teacher required to teach effectively. Such skills include formal education, experience, subject matter knowledge, pedagogy studies, duration of training, certificate/licensing and professional development (Kola and Sunday, 2015). In another perspective, Goe (2007) defined qualifications as resources which teachers bring with them to the classroom and which are considered important in establishing who should be allowed to teach. These resources include teachers' coursework, grades, subject-matter education, degrees, test scores, experience, certification and credentials, as well as evidence of participation in continued learning such as internships, induction, and professional development. Akpan (2012) remarked that a teacher cannot teach the student well, if he or she is not well trained and grounded in the subject he is teaching due to poor qualification. While many studies showed that additional teacher education has a positive correlation with student achievement in some cases, others found that it negatively affects achievement (Greenwald, Hedges, and Laine in Goe, 2007; Hanushek in Kennedy, 2004). Goldhaber and Brewer in Effiong (2018) found that a teacher's advanced degree is not generally associated with increased student learning in Grade 8 to Grade 10, but for Mathematics and Science teachers, having an advanced degree does appear to influence students' achievement. The same was not found to be true for teachers of English or History (Goldhaber and Brewer in Tella, 2020). Tella (2020) found a positive relationship between these variables; with higher levels of performance among students whose teachers held a bachelor's or master's degree in mathematics than among students whose teachers were out-of-field. This is similar to the study done by Etiubon, *et al.*, (2014), Leonard, *et al.*, (2019), and Owolabi, *et al.*, (2012) which revealed that students taught by teachers with higher qualifications performed better than those taught by teachers with lower qualifications. It was also showed that students performed better in physics when taught by professional teachers.

Teacher working experience as a concept is the number of years a teacher has taught. Experienced teachers are argued to have a richer background of experience to draw from and can contribute insight and ideas to the course of teaching and learning, are open to correction and are less dictatorial in classroom (Grady, 2015), which indicated that as the number of years of teaching experience increases, job satisfaction also increases. According to the author, teachers with fewer years of teaching experience have relatively higher satisfaction, regarding salary, than those with many years of teaching experience. Furthermore, the author emphasized that people who stayed in the teaching profession longer are less satisfied with their professional role as teachers than those who are just employed. In an empirical study, Tella (2020) found that years of teaching experience were not significantly related to job satisfaction.

RESEARCH METHODOLOGY

The study employed descriptive survey research design. This design was found fit for the study because the data collected were already on ground and needed not to be manipulated. The study was carried out in Uyo Local Government Area of Akwalbom State. Uyo Local Government Area is situated between the North and South East corner of Akwalbom State. It is located between longitude 7⁰ 40¹ and

5° 40' North of the equator (Department of Geography and Regional Planning, University of Uyo, 2023). Educationally, there are 14 public secondary schools and numerous private secondary schools in Uyo Local Government Area of AkwaIbom State with numerous public and private higher institutions of learning. The choice of the area emanates from the fact that it has the largest number of students' population in AkwaIbom State, as such, what is influencing the students' satisfaction, improve learning commitment and promoting their academic performance in Physics in the area could equally be used to generalize in high extent what affect the other educational zones.

The population of the study comprised of the 36 Physics teachers in the 14 public secondary schools in Uyo Local Government Area of AkwaIbom State. Meanwhile, the senior secondary one students' academic performance scores (SS1) in the 14 public secondary schools served as raters of the teachers' quality. Two researcher's designed instruments tagged "Teachers' Quality Scale (TQS)" and the "Students' Academic Performance Checklist (SAPC)" were used for data collections. TQS was used in eliciting information from the Teachers on their educational qualification, professionalism, and years of working experience. The students' academic performances of the participating schools were gathered from the subject teachers in the sampled schools using the SAPC. The coding scale for the students' academic performance were categorized into four groups: 0-25 point, 26-50 point, 51-75 point, and 76-100 point which represented 1,2,3 and 4 in the analysis. The instruments were validated by experts. The instruments were administered by the researcher to the respondents during school hours using instant retrieval approach. To answer the research questions raised, mean scores was used to assess the differences in students' academic performance in Physics based on teachers' educational qualification, years of working experience, and professionalism. Meanwhile, the null hypotheses formulated were tested using t-test and the analysis of variance.

RESULTS

Research Question 1: What is the differences in Physics teachers' quality in Uyo Local Government Area?

Table 1: Physics Teachers' Quality Chart

Codes Schools	Total Physics Teachers	Teachers' Quality Variables								
		Educational Attainment			Years of Working Experience				Professionalism	
		HND/ Degre e	Masters	PhD	1- 10yrs	11- 20yrs	21- 30yrs	31Above	Education	Non- Edu.
A	2	2	-	-	2	-	-	-	1	1
B	2	2	-	-	1	1	-	-	-	2
C	3	2	1	-	2	1	-	-	1	2
D	2	1	1	-	2	-	-	-	1	1
E	2	2	-	-	1	-	1	-	1	1
F	4	2	1	1	2	-	1	1	2	2
G	3	2	1	-	2	1	-	-	-	3
H	2	2	-	-	2	-	-	-	1	1
I	2	1	1	-	1	-	1	-	1	1
J	3	2	1	-	2	1	-	-	-	3
K	2	1	1	-	1	1	-	-	1	1
L	2	2	-	-	1	1	-	-	-	2
M	5	3	1	1	2	1	1	1	2	3
N	2	2	-	-	1	-	1	-	1	1
Total	36	26(72. 2%)	8(22%)	2(%)	22(61. 1%)	7(19. 4%)	5(13. 9%)	2(6%)	12(33.3%)	24(66.7 %)

(Source Field Survey, Third Term Session, 2023)

Table 1 indicates that majority of Physics Teachers in Uyo Local Government Area were HND/degree holder (72.2%), only within working years of experience of 1-10years (61.1%) without professionalism in education (66.7%). It therefore likely that teachers are not routinely expose to career development and may be those that were exposed must have attrite from the profession. This may be responsible for lack of mentoring, coaching and the resulted failure in students' academic performance in Physics. Meanwhile, these teachers' qualities are represented in Figure 1, 2, and 3 below.

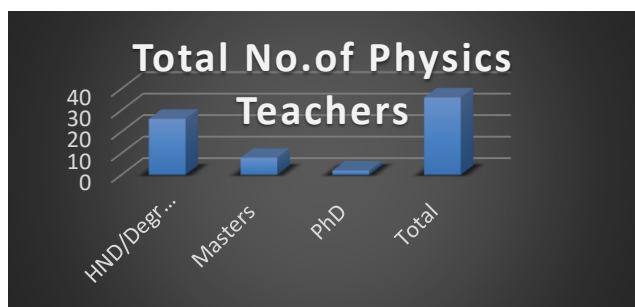


Figure 1: Number of Physics Teachers with regards to Educational Attainment in Uyo Local Government Area

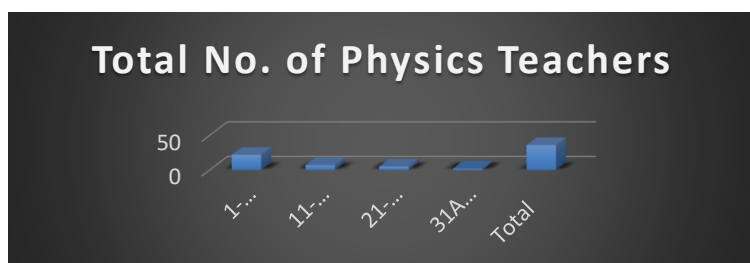


Figure 2: Number of Physics Teachers with regards to Years of Working Experience in Uyo Local Government Area

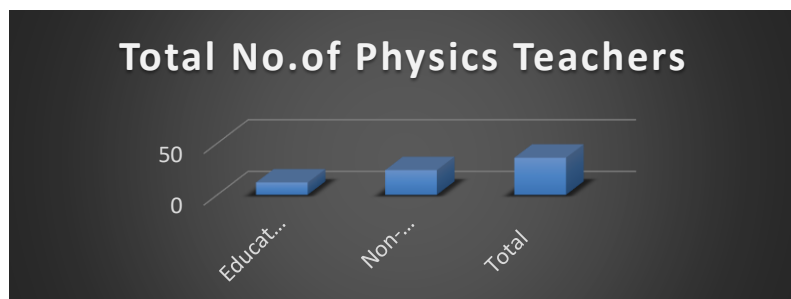


Figure 3: Number of Physics Teachers with regards to Professionalism in Uyo LGA

Research Question 2: What is the difference in students' academic performance in Physics based on teachers' working experience in Uyo Local Government Area?

Table 2: Mean Score Analysis on the Differences in Students' Academic Performance (SAP) based on Teachers' Years of Experience (N=26)

Years	N	Mean of SAP	SD
1-10	22	13.21	3.91
11-20	7	41.01	2.32
21 and above	5	55.09	2.10

Table 2 indicates the mean score of 13.21, 41.01, and 55.09 for the Physics teachers with the years of working experience 1-5, 5-10, and 11 years and above respectively. The result shows that students under the tutelage of teachers with many years of experience had the highest mean score of 55.09 greater than those with lesser number of years. This implies that teachers with the highest years of experience in Physics exhibited more teaching effectiveness than those teachers with lesser experience in the field. Therefore, students' academic performance in Physics differs based on teachers' years of

experience in Uyo Local Government Area. The implication is that students' academic performance in Physics improves along with improved teachers' years of working experience. In other words, teachers who have more experience exhibited more advancement in instructional handling, improve self-esteem, teaching effectiveness and zealously in impacting on their students. The findings of this study is supported by the Etiubon and Benson (2014) but however, contradicted that of Tella (2020).

Research Question 3: What is the difference in students' academic performance in Physics based on teachers' educational qualification in Uyo Local Government Area?

Table 3: Mean Score Analysis on the Difference in Students' Academic Performance (SAP) in Physics Based on Teachers' Educational Qualification (N=38)

Qualification	N	Mean of SAP	SD
HND/Degr	26	37.50	4.11
Masters	8	40.25	3.00
PhD	2	48.62	2.09

Table 3 shows the mean score of students taught by teachers with Doctorate degree (48.62) is the greatest closely followed by those with Master (40.25) and HND/First Degree (37.50) in descending order. In essence, this implies that students' academic performance in Physics differ based on teachers' academic qualification attainment. This implies that students' academic performance in Physics improves along with improved teacher professional development and career advancement. In other words, teachers who have higher degree exhibited more advancement in instructional handling, improve self-esteem, teaching effectiveness and zealously in impacting on their students. In essence, the teachers with higher educational attainment are more proficient in coordinating students' interest, sustaining their concentration, and enhancing their retention on the subject. The findings of this study is supported by the findings of Etiubon and Benson (2014).

Research Question 4: What is the difference in students' academic performance in Physics based on teachers' educational professionalism in Uyo Local Government Area?

Table 4: Mean Score Analysis on the Differences in Students' Academic Performance (SAP) Based on Teachers' Professionalism (N=36)

Profession	N	Mean of SAP	SD
Graduate of Education	12	83.21	0.91
Graduate of other fields	24	41.01	2.32

Table 4 indicates the mean score of 83.21 and 41.01 for the Physics teachers that graduated with education qualification and those from other fields outside education that are just assigned to handle the subject respectively. The result shows that students under the tutelage of teachers with degree in education have the highest mean score of 83.21 greater than those with other non-education degree, 41.01. This implies that teachers who have degree in education specifically in Physics exhibited more teaching effectiveness than those teachers with qualification outside the field of education. Therefore, students' academic performance in Physics differs based on teachers' professionalism in Uyo Local Government Area. The implication is that students' academic performance in Physics improves with teachers' professionalism. In other words, teachers who have degree in education specifically in Physics exhibited more teaching effectiveness than those teachers with qualification outside the field of education.

In essence, the graduates from the field of Physics education are more proficient in coordinating students' interest, sustaining their concentration, and enhancing their retention on the subject. The findings of this study aligned with the position of Oshinyadi (2020) that there is a positive correlation between teacher preparation and students' academic performance, teacher professional development and students' academic performance and a significant impact of teacher preparation pathways on students' academic performance scores.

Recommendations

In light of the conclusion drawn from the findings of the study, the following were recommended to Akwa Ibom State Government (in particular) if quality of students' academic performance in Physics is desired to be sustained:

- (i) Akwa Ibom State Government and corporate organisation should create avenues for workshops and seminars geared towards improving teachers' professionalism vis-à-vis teaching proficiency. This will enhance their efficiency in the coordination of assigned and statutory responsibilities in schools for quality assured educational service delivery.
- (ii) That higher degrees should be encouraged for teachers in secondary schools and high remuneration be given to holders of these degrees.
- (iii) That only qualified Physics teachers should teach the subject at the secondary school level. While the holders of HND/Degree should be allowed to proceed in their education either through part-time or study leave likewise teachers without teaching qualification should pursue their Post Graduate Diploma in Education. As a result, their teaching method shall be improved upon in order to better the performance of students in Physics.

Conclusion

The assessment of the influence of teachers' quality on students' academic performance in Physics has served as a valuable pointer to the development of self before engagement in the management of others. The findings of the study have shown that the teachers handling Physics in Uyo LGA are majorly first degree holders which lack career development opportunities, mentorship, and the requisite knowledge of educational professionalism. However, the study has brought to the fore that only properly qualified teachers with experience and self-confidence can effectively engage, recognize, and supervise students in an effective teaching atmosphere that can assist in the enhancement of students' academic retention as well as encouraging them (the students) to optimally exhibit favorable attitude to work vis-à-vis to the successful academic achievement. Thus, these findings will enhance students' learning effectiveness and efficiency in Physics. Therefore, it is concluded that students' academic performance in Physics improves with teachers' professionalism; that students' academic performance in Physics improves with teachers' years of experience; and that students' academic performance in Physics improves with teachers' higher attainment in education.

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The Role of Education Financing in Enhancing Economic Growth & Alleviating Poverty in Nigeria

¹Akpan, G. E., ^{*2}Akpan, U. R. & ³Iwok, U. A.

¹Professor of Economics, University of Uyo, Uyo

^{*2&3}Department of Economics, College of Education, Afaha Nsit, P.M.B. 1019 Etinan, Akwa
Ibom State, Nigeria

*Corresponding Author Email: ukorobert2015@gmail.com, [Tel:+2348080974484](tel:+2348080974484)

Abstract

The research sought to delve into the intricate dynamics between education financing, economic growth and poverty alleviation in Nigeria, using data spanning over four decades, from 1980 to 2022. Employing a methodological combination of trend analysis and Auto Regressive Distributive Lag (ARDL), the study aimed to unravel the trends, relationships, and consequential impacts of education financing on both economic growth and poverty reduction. The results from the education financing-growth model, dedicated to scrutinizing the nexus between education financing and economic growth, brought forth noteworthy insights. The findings pointed towards a positive and statistically significant influence of education financing on economic growth, discernible in both the short and long run, as evidenced by empirical data from Nigeria. Conversely, the second model, which delved into the association between education financing and poverty alleviation, revealed a statistically insignificant positive impact. This lack of significance was attributed to the glaringly low level of education financing, evident in the stylized facts concerning Total Government Expenditure on Education (TGEE%GDP). The study posited that the insufficient allocation of funds to essential aspects of education acted as a bottleneck to the development of contemporary skills necessary for optimal functioning in a world characterized by limited opportunities. Consequently, a stark scenario of persistent poverty, particularly driven by elevated unemployment rates among graduates, unfolded over the study period. The stylized facts for unemployment exhibited an upward trajectory, underscoring a direct correlation with the inadequacy of education financing relative to the country's burgeoning demand for education as a potent tool for poverty alleviation. In light of these findings, the researcher advocated for strategic interventions, chief among them being a substantial increase in Total Government Expenditure on Education (TGEE) to reach 10% of the Gross Domestic Product (GDP). This proposed augmentation in education financing was positioned as a pivotal solution to address existing challenges and contribute significantly to the overarching socioeconomic development of Nigeria.

Keywords: Education, Financing, Economic growth, Poverty alleviation, Nigeria

INTRODUCTION

Governments aspire to achieve rapid economic growth and alleviate poverty among their citizens, recognizing that education plays a pivotal role in realizing these objectives. Education serves as the bedrock for fostering economic progress and poverty reduction within any nation. Hence, Bloom and Canning (2003) opined that by improving on health and education in Africa, the citizens may contribute to development in the following ways: (i) greater productivity at the workplace which is synonymous to improved income, (ii) ability to work much longer and retire later due to overall good health, (iii) invest more in their own education and training leading to enhanced productivity and; (iv) greater capacity to save and invest more with the expectation of a longer life. To them, health and education outcomes result in inclusive growth, equitable and sustainable access to resources.

It is through education that visionary leaders are nurtured, individuals capable of steering the nation toward prosperity and sustainable development. Educated minds are instrumental in formulating policies that contribute to sustained economic growth, ensuring a strategic and informed approach to national development. Furthermore, education is a catalyst for technological advancement. Innovations emerge from educated minds, and these technologies are diffused to address critical societal issues and streamline various aspects of life. The dissemination of knowledge facilitated by education financing becomes a conduit for the adoption of new ideas and techniques. This dissemination is vital for enhancing the skills and abilities of the workforce, contributing to overall improvements that are indispensable for economic growth and development.

As noted by Obele and Ayaba (2003), national development becomes a challenging endeavor without substantial investment, both qualitative and quantitative, in the education sub-sector. This underscores the belief that education financing is not just an expenditure but a strategic investment in the future of a nation. By channeling resources into education, governments lay the foundation for a more knowledgeable, skilled, and innovative society, fostering an environment conducive to rapid economic growth and poverty alleviation. Umo (2012) emphasized that the initial step in empowering individuals is to afford them the opportunity to receive an education. Education, as Umo articulated, confers upon the less privileged the ability to comprehend and master their living environment, endowing them with the skills requisite for securing a livelihood.

Recognizing the pivotal roles of education in economic growth and poverty alleviation, the federal government of Nigeria took a monumental step in 1969 by organizing the first national curriculum conference in education. This conference aimed to position education as an instrument for national development, as articulated by Ajeyalemi (2009). The outcomes and resolutions of this conference laid the groundwork for the national policy on education, initially published in 1977 and subsequently revised in 1981, 1996, 2004, 2009, and 2013.

According to the national policy on education (2013 edition), the federal government of Nigeria has embraced broad educational objectives. These objectives encompass instilling national consciousness and unity, cultivating the right values and attitudes for individual survival in society, training minds to understand the world, and acquiring appropriate skills and developing mental, physical, and social abilities. These competencies, as outlined in the policy, are viewed as essential equipment for individuals to live in and contribute to the development of the society (Federal Republic of Nigeria, 2013). In essence, education, as conceptualized by these frameworks, emerges as a catalyst for personal development, societal progress, and national prosperity.

Over the course of years, the Nigerian government has endeavored to realize the overarching objectives set for economic growth and poverty eradication. However, there is a prevailing opinion that

the financial allocation to education is insufficient, especially considering the widespread demand for high-quality education in the country. Consequently, despite the surge in school enrollments, the educational infrastructure and facilities have struggled to keep pace with the rapid growth of the educational system, leading to concerns about the adequacy of resources to support an expanding and evolving educational landscape.

In a comprehensive examination of poverty, the Brookings Institution (2018) startlingly declared Nigeria as the new global epicenter of extreme poverty, surpassing India. According to their report, a staggering 86.9 million people in Nigeria were living in conditions of extreme poverty. This disconcerting revelation was echoed by British Prime Minister Theresa May (2018), who emphasized the paradox of Nigeria's economic resurgence coexisting with a stark reality — an alarming 87 million Nigerians subsisting on less than \$1.90 per day, thereby solidifying its status as the nation with the highest number of extremely impoverished individuals worldwide.

Meanwhile, researches have revealed that there is a positive relationship between population and poverty growth rate in Nigeria. According to World Poverty Clock (2020), 105 million Nigerians lived in extreme poverty as at May, 2020. This translates to 51% of Nigeria's population in the same year. As projected by Bill and Melinda Gates foundation (2018), "over 40% of the world's poorest people would live in Nigeria and Democratic Republic of Congo by 2050". But population increase should not be a problem and cause of poverty in any country if the population is given the means to function. No wonder, China with a population of 1.412 billion people in 2021, attains a zero poverty rate in 2020 having reduced the poverty rate steadily from its original rate of 30.5% in 2005 (worldometer, 2022).

It is on this notes that the researcher chooses to investigate the influence of education financing on economic growth and poverty alleviation in Nigeria. The lead question that this paper intends to answer is whether education financing translates to economic growth and also contributes to alleviation of poverty in Nigeria.

The specific objectives are to:

- (i) Examine the trends in education financing, economic growth and Poverty in Nigeria.
- (ii) Examine the relationship between education financing and economic growth in Nigeria.
- (iii) Investigate the relationship between education financing and poverty Alleviation in Nigeria.

The structure of this work comprises six sections. Section 1 serves as the introduction, while Section 2 provides a literature review. Section 3 delineates the methodology employed. Empirical results are presented in Section 4, followed by a discussion in Section 5. Finally, Section 6 offers recommendations based on the study's findings.

The seemingly straightforward question, "What is Poverty?" belies its complexity. The term "Poverty" derives from the Old French "Poverty" and the Latin "Paupertas," both signifying "Pauper" or "Poor." According to Sen (1999), poverty transcends mere income deficits; it is fundamentally about "capability deprivation." Sen posits that an individual experiences poverty when they lack the means to function in terms of their desired actions. In essence, poverty is synonymous with the "lack of capability to function," which may arise from insufficient income or various forms of social deprivation. This nuanced perspective challenges conventional notions, emphasizing the multifaceted nature of poverty encompassing both economic and social dimensions.

To provide a more nuanced understanding, Umo (2012) offers a comprehensive conceptualization of poverty, categorizing it into various dimensions. Absolute or Abject poverty denotes a state of deprivation where an individual lacks the means to afford basic necessities like food, shelter, clothing, and elementary education. Relative Poverty, on the other hand, gauges the extent to which one's income

falls below societal expectations for a decent life, positioning an individual as relatively poor in comparison to others. Capability Poverty introduces a distinctive lens, framing poverty as capability deprivation rather than income or consumption deficiency. This perspective views poverty as a failure in capability, hindering individuals from achieving their desired actions. Additionally, there are other dimensions such as consumption, asset, subjective, knowledge, chronic, and transitory poverty, contributing to a more comprehensive understanding of the multifaceted nature of poverty.

The above definitions demonstrate that the effects of poverty on people are wide-reaching and can lead to lifelong struggles, especially when people don't receive full education. The link between poverty and education is inextricable, because, people living in poverty may stop going to school so they can work. This leaves most of them with no literacy and numeracy skills needed to further their careers. Their children in turn are in similar situation years later, with little income and few options but to leave school and work in order to earn a living.

Education, on the other hand, means different things to different people, culture and society. Ukeje (2002) opined education as a process, a product and a discipline. As a process, education is a set of activities which entails handling down the ideas, values and norms of the society across generations. As a product, education is measured by qualities and traits displayed by the educated persons. And as a discipline, education is defined in terms of benefits of the organized knowledge to which students are exposed to.

Aristotle (384-322 B.C.E.) provides a profound definition of education, portraying it as a systematic process aimed at training individuals to achieve their objectives by fully exercising all their faculties within the societal context. Aristotle's perspective diverges from the views of Socrates and Plato, emphasizing that education's objective transcends the mere acquisition of knowledge. For Aristotle, education is not solely about intellectual enrichment; it encompasses the pursuit of happiness and a virtuous life.

In Aristotle's philosophy, the aim of education extends beyond personal enlightenment; it is intricately linked to the attainment of virtue and a flourishing life. He posits that genuine virtue resides in achieving a good life. Therefore, an individual must possess both intellectual and moral fortitude to effectively contribute to society, benefiting not only themselves but also fostering the broader growth of the community.

Education financing, in Aristotle's context, emerges as a deliberate and conscious effort to establish an environment conducive to learning and the educational process. This effort seeks to enable learners to actively cultivate their potential, fostering spiritual strength, self-control, personality development, intelligence, noble character, and the practical skills essential for personal and societal advancement. Aristotle's timeless insights underscore the holistic nature of education, emphasizing its pivotal role in shaping individuals for the greater good of both themselves and the communities to which they belong.

In this paper, Education Financing is seen as means to human development. Human development here means a conscious and continuous effort of acquiring and increasing the number of people with the requisite skill, knowledge and experience that are crucial for economic growth and development. The economic benefits of human development includes higher productivity arising from more people improving their education, nutrition, health and other economic development indicators through adequate and proper education financing.

The United Nations Development Programme (UNDP, 1990), defines human development as the process of enlarging people choices; such choices allowing them to lead long and healthy life, to be educated, to

enjoy a decent standard of living, as well as political freedom, other guaranteed human rights and various ingredients of self-respect. Therefore, the basic concern of Education Financing then is human development which centres on the capabilities to lead long and healthy lives, be educated, have access to resources and social services needed for a decent standard of living, and be able to participate in the life of the community.

The above concept of economic development is different from economic growth. Haller (2012), opined economic growth as the process of increasing the size of national economies, the macro-economic indicators, especially the GDP per capita is in ascendant but not necessarily in a linear direction, with positive effects on the economy, whereas, economic development shows how growth impacts on the society by increasing the standard of living. A country's economic growth is usually indicated by an increase in that country's gross domestic products (GDP). Generally, GDP is the total monetary value of goods and services produced by a country over a specified period of time. It reflects the value of a country's output.

Hence, the theory of human capital emphasizes education financing as a way of accumulating human capital for economic growth and development. According to Seers (1969), a country can only be said to be developed when such country is able to solve the problem of inequality, poverty, dependency and unemployment. Umo (2012) opined education financing can help to solve these problems by conferring on the poor, the ability to know and master the environment within which he or she lives, and equip him or her with the needed skills to find a means of livelihood. Therefore, education offers the recipient the ability to address and overcome several types of poverty through a productive employment. It could be noted that, for paid employment, formal education is needed for gaining the cognitive attributes and certificates that any employer requires at all levels. Hence, certificate or academic qualification serves as a screening device for the employment selection. Meanwhile, to be self-employed, one needs quality education to master the skills before setting up as a successful entrepreneur, and basic education enhances trainability, as it is difficult for one to absorb training and benefits from employment without basic education.

Umo (2012) emphasized that education sector contains cognitive skills, knowledge, technology, socio-political networking skills, health and migration which today underpins economic development. In this sense, education is indispensable for inventions, innovations, discoveries and extending frontiers of knowledge which serve as the most effective instrument of inclusive development. And, Owens (1987) suggested that development is when there is development of people (human development) and not development of things.

Nevertheless, the awareness of the role of education to economic growth and development dates back to Adam Smith. Smith (1776) recognized the importance of educational investments to economic growth and development by emphasizing that *"the acquired and useful abilities of all inhabitants or members of the society, the acquisitions of such talents, by the maintenance of the acquirer during his education, study or apprenticeship, always cost a real expense, which is a capital fixed and realized, as it were, in his persons those talents, as they make a part of his fortune, so do they likewise that of the society to which he belongs. The improved dexterity of a workman may be considered in the same light as a machine or instrument of trade which facilitates and abridges labour, and which though it costs a certain expense, repays the expense with a profit."* In this sense, Smith advocated for investment in individuals as a means of developing the individuals in particular and the society in general.

The above definition implies that education is an economic good because, quality education demands a very high cost of production, thus, the need to prioritize its demand. This means that quality

education to a greater extent is the determinant of success, any nation has in developing its economy to curb poverty and for technological innovations. For education to contribute to economic development, it must be of high quality and must match the skills demand in the economy. High quality education depends on the investments in the sector. With investments in education, three major effects can be expected: increase expenses as the accumulation of human capital requires investment just as physical capital; increase productivity as people gain characteristics that enables them to produce more output; and return on investment in the form of higher income.

The endogenous growth model supports the inclusion of human capital in the Cobb-Douglas production function and discovered that economic development is primarily determined by endogenous forces as against the external forces. The endogenous growth model holds that investment in human capital; innovation and knowledge are significant contributors to economic growth. This means that economic growth in the long run is attributed to the accumulation of human capital. In order to produce human capital, education should be used. The theory focuses on positive externalities and spillover effects of education which lead to economic development. It shows that long run growth rate of an economy is a function of policy measures. For instance, subsidies for research and development or education increase the economic growth rate in Romo (1990) and Lucas (1998) models by increasing the incentive for motivation.

The proponents of Human Capital Theory (HCT), Smith (1776) and Becker (1964) opined education financing is highly instrumental and necessary to improve the productive capacity of the population. HCT states that educated population is the active population. The proponents of HCT see education financing as an investment in human beings which is more beneficial than an investment in physical capital. The basic concept of the HCT is that investment in individual can be mathematically measured based on the value they are able to contribute to the society.

Schumpeter (1912) theory of innovation and development emphasizes that government support can significantly promote process innovation, industry-university-research knowledge integration and increase corporate performance. The theory sees innovation as the changes in the methods of production and transportation, production of new product, opening up of new market, etc. It adumbrates the process of technological change in a free market economy like Nigeria to consist of the following three parts: (1) Invention: -which means conceiving a new idea or process, (2) Innovation: - meaning to arrange the economic requirements for implementation of an invention and, (3) Diffusion:- a situation whereby people observing the new discovery adopt or imitate it. It opines “creative destruction” is inevitable in a developing economy. Creative destruction is a situation where booms and recessions are inevitable and cannot be avoided or corrected without distorting the creation of new wealth through innovation. It is a process in which new innovations replace and make obsolete older innovations.

Bakare (2012), used Spearman Rank Correlation coefficient approach to examine the demand for education and economic growth in Nigeria. The findings revealed a positive correlation between demand for education and economic growth. This implies that higher school enrolments will lead to economic growth. The study concluded that effective ways to combat illiteracy, poverty, hunger and stimulate economic growth that is truly sustainable is through education. Although a positive relationship is established here between school enrolment and economic growth in Nigeria, there is need to establish causality between the two variables and this study fulfilled this provision by using school enrolment as one of the variables in running a regression analysis to measure the extent to which economic growth depends on school enrolment in Nigeria.

Lloyd (2018) investigated government spending on education and economic growth in West African Countries. Data for the study covers the year 1990 to 2016 for 15 selected ECOWAS countries. Unit root co-integration analysis and casualty tests were conducted. The study findings include that government spending on education and economic growth in West African countries are positively and significantly related. Long-run Granger causality exists while there is no evidence of short-run Granger causality from government educational expenditure to economic growth. It indicated that in the long-run, government educational expenditure through its impacts on human capital, significantly and positively influenced economic growth. The study recommended collaborative spending on education among West African countries.

Ihugba; Ukwunna and Obiukwu (2019), examined the impact of government education expenditure on Primary School enrolment in Nigeria by applying the bounds testing (ARDL) approach to co-integration for the period 1970 to 2017. The model was constructed to identify the relationship between the two variables while also considering the interaction with control variables; per capita income, remittances, investment and population growth. The bounds tests suggest that the variables of interest are bound together in the long-run when primary school enrolment is the dependent variable. It was observed that an insignificant positive relationship exist between government education expenditure and primary school enrolment. This insignificant relationship was explained by low spending on education. Population growth has a positive relationship in a short run but a negative relationship in a long-run. The speed of adjustment to equilibrium is 88% within a year when the variables wander away from their equilibrium values. The study recommends that government policies directed at improving the expenditure towards education should largely increase, and money meant for the education sector should be distributed with high degree of transparency.

Dauda (2010), empirically investigated the relationship between investment in education and economic growth in Nigeria using annual time series data from 1977 to 2007. The paper employs Johansen Cointegration technique and error correction methodology. Empirical results indicated that there is a long-run relationship between investment in education and economic growth. All the variables including labour force, gross fixed capital formation and educational capital appear with the expected positive signs and are statistically significant (except labour force) in the Nigerian economy. The findings have a strong implication on educational policy in Nigeria. The study suggested that a concerted effort be made by policy makers to enhance educational investment in order to accelerate growth which would engender economic development.

Ifionu and Nteegah (2013), examined the impacts of government investments in education on economic growth in Nigeria over the period 1981 to 2012. Economic growth proxied by GDP growth rate was the dependent variable while government capital expenditure on social services, recurrent expenditure on education, primary schools' enrollment and primary schools' pupils teacher ratio were explanatory variables. Employing the OLS technique, the paper found that government capital expenditure on social services (education and health) and government recurrent expenditure on education have significant implications on economic growth during the period of the study. The paper recommends an increase in government budgetary allocation to the education sector from the present less than 15% to UNDP/UNESCO requirement of 25% allocation to the sector, improvement in the welfare of educationists and regular monitoring of funds and services rendered in the sector to ensure improved standards as possible ways of making education growth friendly sector in the country.

Akpan, Okposin and Sunday (2022) investigated the influence of educational investments on sustainable development in Nigeria using data from 1999 – 2018. Trend Analysis Technique and Ordinary

Least Square (OLS) method were adopted for the study. The key variables considered in their analysis were: HDI, TGEE, RGDP growth rates, interest rate spread, unemployment rate and capital expenditure as a percentage of GDP in Nigeria. The result revealed a downward trend of educational investment as a ratio of GDP but an upward trend of economic development in Nigeria. The impact analysis indicated a positive influence of educational investment on sustainable development in Nigeria. The study recommended that if educational investment in Nigeria is increased, it will stimulate the country's economy to fully employed available resources and achieved better standard of living for all Nigerians.

In summary, the literature review underscores the nuanced and varied causal relationships between education financing, economic growth, and poverty alleviation across countries. Disparities arise from differences in education measurement, study characteristics, model specifications, types of data utilized, research quality, and the socio-economic development levels of the observed countries. The earlier studies primarily focused on economic growth, often neglecting critical variables essential for comprehensively assessing the impact of education financing on poverty alleviation in Nigeria. To enhance the robustness of our models and discern the impact of education financing on economic growth and poverty alleviation, the researcher incorporates key variables such as real GDP growth rates, total government expenditure on education as a percentage of GDP, school enrollments, graduates outturn, exchange rates, inflation rates, unemployment rates, interest rates, and the Human Development Index (HDI). The inclusion of these variables aims to provide a more comprehensive understanding of the multifaceted relationship between education financing, economic dynamics, and poverty outcomes. The study utilizes secondary data spanning from 1980 to 2022, ensuring a comprehensive and contemporary analysis.

RESEARCH METHODOLOGY

The research design selected for this study is the Ex Post Facto Design. Kerlinger (1964) characterizes ex post facto research as an approach wherein the independent variable or variables have already taken place, and the researcher commences the study by observing the dependent variable or variables. Also known as "after the fact research," this design investigates how a group with specific qualities of independent variables, pre-existing before the study, influences a dependent variable. Importantly, this method underscores that the independent variables possess inherent characteristics or traits that cannot be manipulated in the research setting, distinguishing it from experimental designs where researchers can control and manipulate independent variables.

Model Specification

In this study, the model for economic growth is specified as:

$$\text{GDPGR} = f(\text{TGEE}, \text{SSE}, \text{GOT}, \text{INTR}, \text{INFL}, \text{EXTR}) \quad 1.1$$

Where: GDPGR = Real Gross Domestic Product Growth Rates

TGEE= Total Government Expenditure on Education as a Ratio of GDP

SSE= School Enrolments in Millions

GOT= Graduates Out-turn as a Ratio of Total Out-turn in Nigeria

INF= Inflation Rates

INTR= Real Interest Rates

EXTR= Exchange Rates

During estimation, parameters are introduced and a disturbance term (U) to take care of variables not included in the model but affect economic growth and development. Therefore, equation1 above is transformed thus:

$$GDPGR_t = b_0 + b_1TGEE_t + b_2LOG(SSE_t) + b_3GOT_t + b_4INF_t + b_5INTR_t + b_6EXTR_t + U_t \quad 1.2$$

The dynamic model of equation2 after expressing same in log-linear form is specified as:

$$GDPGR_t = b_0 + b_1TGEE + b_2lnSSE + b_3GOT_t + b_4INF_t + b_5INTR_t + b_6EXTR_t + U_t \quad \text{If 1.3}$$

Whereas, the model for poverty alleviation is specified as:

$$HDI = b_0 + b_1TGEE + b_2GOT_t + b_3UNEMP_t + b_4GDPgr + U_t \quad 1.4$$

Where: UNEMP= Unemployment Rates.

The Human Development Index (HDI) serves as a pivotal proxy for assessing poverty alleviation. In the context of this study, b1, b2, b3, b4, b5, and b6 represent the elasticities quantifying the impacts of various factors, including total government expenditure on education, school enrollment, graduates out-turn, inflation rates, interest rates, exchange rates, and unemployment rates, on both economic growth and poverty alleviation within the Nigerian context. These coefficients play a crucial role in elucidating the intricate relationships between these variables and the outcomes under investigation.

Apriori Expectations

The signs in the Parenthesis represent apriori expectations of each of the variables used in this study: TGEE (+), SSE(+), INF (+), GOT (+) INTR (-), EXTR (+), UNEMP (-).

Co-integration and Error Correction Model

Co-integration analysis is imperative for economic models utilizing non-stationary time series data. This precaution is crucial because, in the absence of co-integration, the risk of spurious regression arises, rendering econometric studies meaningless or even 'nonsensical'. Conversely, when stochastic trends offset each other, co-integration occurs, prompting the need for an error correction model (ECM). An ECM proves advantageous as it incorporates both long-run and short-run information, offering a comprehensive understanding of the model dynamics. In instances where there exists a long-run impact among variables, equations 3 and 4 can be transformed into an error correction model, enhancing the model's ability to capture and interpret both short-term fluctuations and long-term trends.

$$GDPGR_t = b_0 + b_1\Delta TGEE_t + b_2\Delta lnSSE + b_3\Delta GOT + b_4\Delta INF_t + b_5\Delta INTR_t + b_6\Delta EXTR_t + \lambda ECM_{t-1} + V_t \quad 1.5$$

$$HDI_t = b_0 + b_1\Delta TGEE_t + b_2\Delta GOT + b_3GDPGR_t + b_4\Delta UNEMP_t + \lambda ECM_{t-1} + V_t \quad 1.6$$

Where: $ECM = (\Delta GDPGR_t - b_0 - b_1\Delta TGEE_t - b_2\Delta lnSSE_t - b_3\Delta GOT_t - b_4\Delta INF_t - b_5\Delta INTR_t - b_6\Delta EXTR_t)_{t-1}$ = adjustment parameter which shows the extent to which the disequilibria in the dependent variables (GDPGR and HDI) are being corrected each period.

Δ = first difference operator

$$V_t = \Delta U_t = (U_t - U_{t-1})$$

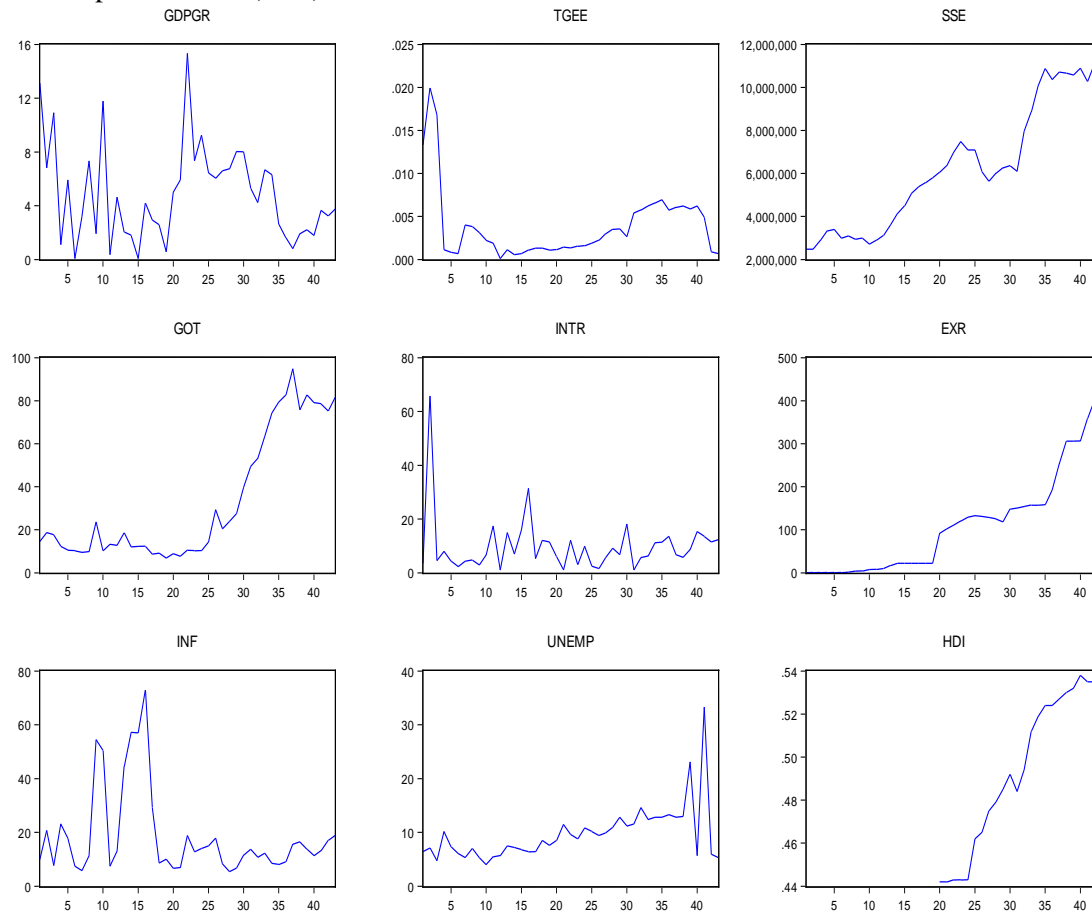
Either equation 3 and 4(if there is no long-run impact among the variables) or equation 5 and 6 (in case of a long-run impact among the variables) will be estimated. Hence, the second objective of this research

work shall be captured by the respective test of significance on each of the explanatory variables and by evaluating the signs and magnitude of the elasticity.

RESULTS

Objective 1: Analyze the patterns in education financing, economic growth, and poverty alleviation in Nigeria spanning the period from 1980 to 2022

Descriptive Analysis of Education Financing, Economic Growth and Poverty in Nigeria are presented in this section. The stylized facts are for Gross Domestic Product Growth Rate (GDPGR) which serves as a proxy for economic growth, Total Government Expenditure on education (TGEE) as a proxy for Education financing which is the major explanatory variable, Schools enrolment (SSE), Graduates Out turned (GOT), Unemployment Rate (UNEMP), Interest Rate (INTR), Exchange Rate (EXR) and Human Development Index (HDI).



Figures: Trend Analysis of the major variables in the study, 1980-2022. Source: Author's computation using E-views 9 (2023)

The trend line for GDPGR is erratic for the period under review; the graph shows sharp increases and decreases between different years within the time range. For example, the lowest growth were recorded in the year 1986 and 1995 with a value of 0.06% and 0.07% respectively within the two time period, whereas, the highest GDPGR was recorded in the year 2002 with the value of 15.32%. The reason for the volatility in the GDPGR may be attributed to the instability in the Nigeria's economy as regarded the policy formulation and implementation.

Figure 2 shows the trend of TGEE% of GDP. It is observed that the TGEE% GDP is relatively flat for most of the period under review, except for the sharp decrease in TGEE value between 1983 and 1985. The lowest percentage of TGEE% GDP was recorded in 1991 and the graph turned erratic with increase and decrease values till 2009. The graph exhibited an increasing trend between the year 2010 to 2014 but declined again in 2015 and continued being flat. The pattern of the GDPGR above could also be attributed to the behaviour of TGEE% GDP.

A look at figure 3 and 4 above revealed upward trends in Schools enrolment and graduate output. Although the figures were slow over the years, it is important to notice that the trends were increasing. Hence, it is a good sign for Economic growth and poverty alleviation in the country if the education obtained is qualitative enough to equip the beneficiaries with the means to function optimally in any environment, they find themselves. It also represents economic growth and poverty alleviation in the country as more people are expected to be opportune to break away from poverty by being gainfully employed after some years of schooling. The trend analysis shows that real exchange rate is positive over the years. This may be a good sign to a sustainable growth in Nigeria as export is encouraged since price of identical baskets of goods is expected to be equal when expressed in common currency terms and this condition is commonly referred to as purchasing power parity. Figure 8 shows an increasing trend in Unemployment rate in Nigeria. This may be one of the reasons for the erratic trend in the Growth rate, as both human and material resources within the economy are not fully employed and utilized for maximum economic performance, hence, resulting in more people being poor in the country.

A look at the figure above revealed an upward trend in HDI which is the proxy for poverty alleviation. Although the increase is very slow over the years, it is important to notice that the trend was increasing, indicating an increase in the standard of living of people in the country over time. The question of whether this poverty alleviation was impacted by education financing shall be answered in the objective 2 when analyzing the signs and magnitude of TGEE % Of GDP.

Objective 2: Investigate the correlation between education financing, economic growth, and poverty alleviation in Nigeria

Unit Root Test

The data were tested for unit root before conducting the regression analysis. This was done because regressing non-stationary data can give spurious output. Thus, to avoid this, the Augmented Dickey-Fuller (ADF) Unit Root test was carried out on all the sub-variables. The results of the ADF test statistics is presented in Table 1.

Table 1: Augmented Dickey Fuller Unit Root Test Result

Variable	ADF	1% critical value (**)	5% critical value (*)	Order of integration
GDPGR	-14.09158	-3.600987	-2.935001	I(1)
TGEE%GDP	-6.113410	-3.600987	-2.935001	I(0)
LOG(SSE)	-5.050219	-3.600987	-2.935001	I(1)
GOT (%)	-7.458677	-4.198503	-3.523623	I(1)
UEMP	-4.151301	-4.192337	-3.520787	I(0)
EXR	-4.242541	-3.600987	-2.935001	I(1)
INF	-3.601884	-3.600987	-2.935001	I(0)
INTR	-7.110723	-3.596616	-2.933158	I(0)
HDI	-4.541457	-3.769597	-3.004861	I(1)

Source: Author's computation using E-Views 9 (2024)

The result of the unit root test for the Augmented Dickey fuller test shows that all the variables used for this study were stationary at level and first difference order of integration as shown in table 1, as such, the study is justified to employ the Auto Regressive Distributive lag (ARDL) method to test for long run relationship.

ARDL Bound Test

The ARDL Bound Test for Co-integration was employed to determine the presence of a long-term relationship among the variables, following the confirmation of data being free from unit root. In Table 2, the calculated F-statistics value of 5.87 surpasses both the upper-bound critical value of 2.45 and the lower-bound critical value of 3.61 at the 5% significance level. This rejection of the null hypothesis, indicating no co-integration or significant long-term relationship among the variables, suggests the presence of co-integration—a substantial long-term relationship between the examined variables. This outcome supports the notion that the variables are interrelated over an extended time horizon.

Table 2: ARDL Bound Test Result

Test Statistic	Value	K
F-statistic	5.873811	6
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.12	3.23
5%	2.45	3.61
2.5%	2.75	3.99
1%	3.15	4.43

Source: Authours Computation using E-views 9 (2024)

Objective 2: Investigate the correlation between education financing and economic growth in Nigeria.

Table 3: ARDL Short run Long run Error Correction Test Result

Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TGEE)	552.605346	180.858448	3.055458	0.0044
DLOG(SSE)	2.282869	2.064127	1.105973	0.2765
D(GOT)	-0.134742	0.037334	-3.609096	0.0010
D(EXR)	0.017172	0.009620	1.785010	0.0832
D(INF)	0.017460	0.034870	0.500704	0.6198
D(INTR)	-0.082155	0.056678	-1.449518	0.1564
CointEq(-1)	-0.944168	0.146397	-6.449378	0.0000
Cointeq = GDPGR - (585.2828*TGEE + 2.4179*LOG(SSE) -0.1427*GOT + 0.0182*EXR + 0.0185*INF -0.0870*INTR -31.8944)				
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
TGEE	585.282837	195.499836	2.993777	0.0051
LOG(SSE)	2.417863	2.195071	1.101497	0.2784
GOT	-0.142709	0.040468	-3.526448	0.0012
EXR	0.018188	0.010478	1.735721	0.0917
INF	0.018492	0.037674	0.490836	0.6267
INTR	-0.087013	0.063433	-1.371738	0.1791
C	-31.894375	33.518824	-0.951536	0.3480

Source: Authour's Computation using E-views 9 (2024)

Objective 3: Investigate the correlation between education financing and poverty alleviation in Nigeria

Table 4: ARDL Short Run Test Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
HDI(-1)	0.850271	0.161473	5.265720	0.0001
TGEE	0.708057	0.949717	0.745545	0.4661
GDPGR	7.37E-05	0.000681	0.108229	0.9151
GOT	0.000137	0.000208	0.659938	0.5181
UNEMP	-0.000233	0.000262	-0.890641	0.3856
C	0.070668	0.071352	0.990417	0.3359
R-squared	0.974654	Mean dependent var		0.496609
Adjusted R-squared	0.967199	S.D. dependent var		0.034959
S.E. of regression	0.006332	Akaike info criterion		-7.067095
Sum squared resid	0.000681	Schwarz criterion		-6.770879
Log likelihood	87.27159	Hannan-Quinn criter.		-6.992597
F-statistic	130.7418	Durbin-Watson stat		2.108426
Prob(F-statistic)	0.000000			

Source: Author's computation using E-views 9(2024)

Diagnostic Tests

Diagnostic tests for serial correlation and heteroskedasticity were performed, and the outcomes are outlined in Table 3 below. The serial correlation results reveal the absence of serial correlation in the model's errors. The heteroskedasticity test indicates that the variance in the model is uniformly

distributed. Furthermore, the normality test of the model attests to the equation's adherence to a normal distribution, affirming the appropriateness of the model for statistical analysis. These diagnostic assessments contribute to the robustness and reliability of the model's results.

Table 5: Summary of the Post Diagnostic Tests Result

Test	R ² Statistics	Probability Value
Breusch-Godfrey LM test for serial correlation	3.799414	0.1496
Breusch – Pagan - Godfrey Heteroskedasticity	3.403587	0.8453
Normality Test	1.663680	0.4352

Source: Author's computation using E-Views 9 (2024)

DISCUSSION

The results of the ARDL short-run long-run error correction test, as presented in Table 3, unveil a positive and significant relationship between education financing and economic growth in Nigeria, both in the short run and the long run. Specifically, the findings suggest that a unit increase in education financing corresponds to a significant increase of 585.28 units in economic growth, surpassing the 5% level of significance. The error correction term $CointEq(-1)$ exhibits the expected sign, negative, and is significant at a 5% probability level. This implies the presence of long-run equilibrium among the time series for education financing and economic growth.

The slope coefficient of the error correction term, at 0.944168 in absolute terms, signifies the speed of adjustment, aligning with the hypothesis of convergence towards long-run equilibrium. Notably, this coefficient indicates that approximately 94.41% of short-run disequilibrium and inconsistencies are being corrected and adjusted toward the long-run equilibrium path. These results echo the findings of Lloyd (2018), whose study emphasized the positive impact of government education expenditure on human capital, significantly influencing long-term economic growth and development. Additionally, Akpan, Okposin, and Sunday (2022) recommended that increased educational investment in Nigeria would stimulate the economy, leading to full employment of available resources and an improved standard of living.

Despite these positive associations, the stylized facts reveal a lack of commitment from Nigeria to elevate its education financing levels. While education financing exhibits a positive and significant influence on economic growth (as seen in Table 3), the influence on poverty alleviation is found to be insignificant (Table 4). This insignificance is attributed to the markedly low levels of education financing, as indicated by the stylized facts for Total Government Expenditure on Education as a percentage of GDP (TGEE%GDP). The inadequacy of funding results in insufficient support for teachers' welfare, school infrastructure, and facilities, hindering learners from acquiring the modern skills needed for optimal functioning in a world of limited opportunities.

Table 4 underscores the positive impact of school enrollment on sustainable economic growth, aligning with Bakare's (2012) assertion that higher school enrollments contribute to economic growth and development. However, when higher school enrollments are not complemented by adequate education financing, it may lead to economic growth and development challenges. The pressure on existing

educational facilities without corresponding funding leads to wear and tear with minimal replacements. This, in turn, lowers teacher morale due to insufficient funds for on-the-job training and welfare, while the quality of education output suffers due to inadequate attention to learners and a lack of modern technology use. In the long run, this adversely affects the quality of labor, human capital, and outputs, resulting in unemployment, poverty, dependency, insecurity, and other economic challenges.

The erratic nature of the stylized fact in Figure 1 further confirms the inconsistency in economic growth in Nigeria over the studied period. This inconsistency is reflective of the challenges associated with the educational sector, where low financing hampers the sector's capacity to meet the evolving needs of learners and the broader economy. In conclusion, the study highlights the critical importance of adequate education financing to not only drive economic growth but also to effectively address poverty alleviation challenges by equipping individuals with the skills necessary for meaningful participation in a rapidly changing world.

RECOMMENDATIONS

- (i) It is imperative for the government, recognizing its pivotal role in national development, to urgently prioritize and augment Total Government Expenditure on Education (TGEE) from its present level to 10% of the Gross Domestic Product (GDP). Sustaining this heightened investment is crucial to fostering enduring economic growth and significantly advancing poverty alleviation initiatives in the country. This strategic move underscores the government's commitment to building a robust educational foundation as a cornerstone for broader socioeconomic progress and improved well-being for its citizens.
- (ii) The government must institute proactive policies aimed at empowering Nigerians to optimize the economic benefits derived from favorable exchange rates in the country. Initiatives such as lowering interest rates specifically for graduate entrepreneurs seeking venture capital, expanding the accessibility of credit facilities, fostering collaboration among economic stakeholders, and providing subsidies to firms engaged in the production of export commodities could be pivotal. These policy measures are poised to create an environment conducive to capitalizing on positive exchange rate impacts, promoting entrepreneurship, and stimulating economic growth.
- (iii) Coppersrate organizations are urged to capitalize on the positive outcomes associated with increased school enrollments, as demonstrated in this study, by actively supporting education financing initiatives in the country. Such support can play a pivotal role in fostering process innovation, facilitating the integration of knowledge among industry, universities, and research institutions, ultimately leading to an enhancement in corporate performance. By investing in education financing, corporate entities contribute not only to the development of a skilled workforce but also to the overall growth and competitiveness of the nation's economy.

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Assessment of Laboratory Safety Practices in Secondary Schools: Implications for Science Education in Akwa Ibom State, Nigeria.

¹Archibong, A. U. ^{*2}Osu, S. R. & ³Udoidiok, D. E.

¹Department of Integrated Science, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria. Email: archibongalbert@yahoo.com, Tel: +2348022992270

^{*2&3}Department of Biology, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria.

*Corresponding Author Email: samuelrobert2007@yahoo.com, Tel: +2348028260825

Abstract

This study assessed laboratory safety practices in secondary schools across the three senatorial districts of Akwa Ibom State, Nigeria. The aim was to evaluate the awareness and adherence to safety protocols among teachers and students, identify challenges related to laboratory safety, and propose recommendations for improvement. Data were collected from six schools (two each from Eket, Uyo, and Ikot Ekpene Senatorial Districts) using two separate Likert scale questionnaires, one for teachers and one for students. A total of 120 teachers and 120 students were sampled, with 20 students per school and 6 teachers per school. The study utilized descriptive statistics, Chi-square tests, and T-tests for data analysis. The results revealed that 45% of teachers lacked adequate knowledge of safety protocols, while only 25% of students consistently adhered to laboratory safety rules. A significant difference was found in the adherence levels between teachers and students ($p < 0.05$), indicating that teachers were more aware of safety measures. Furthermore, 70% of the schools had outdated safety equipment, which was a major concern. Recommendations include the regular training of teachers on laboratory safety and the procurement of modern safety equipment for schools. Additionally, safety education should be integrated into the science curriculum to foster a safety culture among students. These recommendations are aimed at reducing the number of accidents in laboratories and improving the overall safety standards in science education in Akwa Ibom State.

Keywords: Laboratory Safety, Secondary Schools, Akwa Ibom State, Teacher Awareness, Student Compliance,

INTRODUCTION

Laboratory safety in schools is a critical component of science education that directly impacts both the teaching and learning process. The laboratory is a fundamental part of science education, providing students with hands-on experience that reinforces theoretical knowledge and promotes critical thinking (Nwosu, 2015). However, despite its importance, laboratory safety practices in many secondary schools in Nigeria remain a challenge. Unsafe laboratory practices can result in accidents, injuries, and health risks, particularly for students who are not fully aware of safety protocols (Adeoye & Eze, 2021). Inadequate safety equipment, lack of proper training for both teachers and students, and insufficient enforcement of safety rules contribute to these hazards (Okafor, 2017).

In Akwa Ibom State, like many other regions in Nigeria, schools are faced with the dual challenge of providing quality science education while ensuring the safety of students and teachers in laboratory environments. The state is divided into three senatorial districts: Eket, Uyo, and Ikot Ekpene, each with its own set of challenges related to laboratory safety (Akpan & Usoro, 2018). While some schools are well-equipped with safety gear, others are plagued by outdated or insufficient equipment and lack of trained personnel to enforce safety measures (Ekpo & Akpan, 2019).

Teachers play a crucial role in maintaining laboratory safety, as they are responsible for guiding students through safe laboratory practices (Adegoke, 2014). However, the ability of teachers to effectively enforce safety guidelines is often compromised by a lack of resources and proper training (Ogunleye & Akinbobola, 2015). Similarly, students, who are expected to follow safety protocols during experiments, often lack the necessary awareness and discipline to adhere to these rules (Ajao, 2020).

Studies have highlighted varying levels of awareness and compliance with laboratory safety protocols among students and teachers. Akinola (2020) found significant deficiencies in laboratory safety equipment, noting a notable lack of essential items such as fire blankets, first aid kits, and adequate personal protective equipment. Similarly, a study by Udoh (2013) aimed at determining the status of safety awareness among senior secondary school science students in Akwa Ibom State revealed gaps in students' knowledge of safety practices, underscoring the need for enhanced safety education.

The availability and proper utilization of safety equipment are paramount for effective laboratory safety. Etiubon and Udoh (2020) examined the availability and utilization of laboratory facilities for teaching carbohydrates in senior secondary schools in Uyo Education Zone, Akwa Ibom State. Their findings indicated that while some schools possessed basic laboratory facilities, there was a lack of essential safety equipment, and existing facilities were often underutilized. This inadequacy poses significant risks during laboratory sessions.

Implementing effective laboratory safety practices in Nigerian secondary schools faces several challenges. A study by Akpan, Uwak, and Etukufot (2023) assessed the influence of laboratory technicians' characteristics on support to science teaching in secondary schools in Uyo Senatorial District. The study found that educational qualifications of laboratory technicians significantly influenced their support for science teaching, suggesting that inadequate training and qualifications among laboratory staff could hinder the implementation of safety practices.

The state of laboratory safety directly impacts the quality of science education. A well-equipped and safe laboratory environment enhances students' interest and performance in science subjects. A study examining the potency of laboratory and library facilities in promoting students' interest and performance in physics in Akwa Ibom State concluded that active participation in laboratory activities significantly boosts students' conceptual understanding and retention of scientific concepts. However, deficiencies in safety practices can deter students from fully engaging in practical work, thereby impeding learning outcomes (Eyenaka & Umoren (2024).

This study, therefore, seeks to assess the laboratory safety practices in secondary schools across the three senatorial districts of Akwa Ibom State. It will explore the awareness and compliance levels of both teachers and students, identify challenges faced by schools in implementing safety protocols, and recommend strategies for improving laboratory safety standards. The findings from this study will contribute to enhancing the safety of science education in Akwa Ibom State and, by extension, Nigeria.

Aims and Objectives of the Study

The study aims to assess laboratory safety practices in secondary schools across the three senatorial districts of Akwa Ibom State, Nigeria, and to evaluate their implications for science education. It seeks to determine the level of awareness, compliance, and challenges related to laboratory safety among teachers and students, with a view to improving science education through enhanced safety measures.

The specific objectives of this study are to:

- (i) Examine the level of awareness of laboratory safety practices among science teachers and students in secondary schools in Akwa Ibom State.
- (ii) Assess the extent of compliance with standard laboratory safety guidelines by both teachers and students during practical sessions.
- (iii) Identify the availability and adequacy of safety equipment, such as fire extinguishers, first aid kits, personal protective equipment (PPE), and emergency exits in the school laboratories.
- (iv) Evaluate the role of science teachers in ensuring safety compliance and training students on proper laboratory procedures.
- (v) Investigate the challenges faced by schools in implementing laboratory safety measures.
- (vi) Determine the impact of laboratory safety practices on students' participation, performance, and interest in science education.
- (vii) Provide recommendations for improving laboratory safety standards in secondary schools to enhance effective science teaching and learning.

Research Questions

Based on the study's objectives, the following research questions are formulated:

- (i) What is the level of awareness of laboratory safety practices among science teachers and students in secondary schools in Akwa Ibom State?
- (ii) To what extent do teachers and students comply with standard laboratory safety guidelines during practical sessions?
- (iii) How adequate are the available laboratory safety equipment and facilities in the selected secondary schools?
- (iv) What role do science teachers play in ensuring laboratory safety and training students on safety procedures?
- (v) What challenges do schools face in implementing effective laboratory safety measures?
- (vi) How do laboratory safety practices impact students' participation, performance, and interest in science education?
- (vii) What strategies can be adopted to improve laboratory safety standards in secondary schools in Akwa Ibom State?

Research Hypotheses

The following null hypotheses (H_0) were raised to guide the study:

- (i) H_{01} : There is no significant difference in the level of laboratory safety awareness between science teachers and students in secondary schools.
- (ii) H_{02} : There is no significant relationship between laboratory safety compliance and students' academic performance in science subjects.
- (iii) H_{03} : The availability and adequacy of laboratory safety equipment do not significantly impact students' compliance with safety rules.

- (iv) H₀₄: Science teachers' roles in laboratory safety enforcement do not significantly influence students' adherence to safety procedures.
- (v) H₀₅: There are no significant challenges affecting the implementation of laboratory safety measures in secondary schools.
- (vi) H₀₆: Laboratory safety practices do not significantly influence students' interest in science education.
- (vii) H₀₇: The adoption of improved laboratory safety strategies will not significantly enhance the teaching and learning of science subjects.

Statement of the Problem

Laboratory safety is an essential aspect of science education, ensuring that both teachers and students can conduct experiments and practical activities in a secure environment. However, many secondary schools in Akwa Ibom State face challenges in maintaining proper safety standards, leading to accidents, health risks, and limited student engagement in laboratory activities. The lack of adequate safety equipment, poor enforcement of safety protocols, and limited training in laboratory safety contribute to these issues.

Science teachers play a crucial role in laboratory management, yet their level of safety awareness and compliance with standard procedures remains questionable. Additionally, students' knowledge of safety rules and their adherence to protective measures during practical sessions are often inadequate. The situation is further compounded by infrastructural deficiencies, insufficient government support, and a lack of comprehensive safety policies in many schools.

Given these concerns, it is necessary to evaluate the current state of laboratory safety practices in secondary schools across the three senatorial districts of Akwa Ibom State—Eket, Uyo, and Ikot Ekpene. This study seeks to assess the level of awareness, compliance, and challenges associated with laboratory safety in these schools. Understanding these issues will provide valuable insights into improving safety standards, ensuring better protection for students and teachers, and enhancing the quality of science education.

Significance of the Study

This study is significant in several ways:

- (i) **Improving Laboratory Safety Practices:** The findings will highlight the current safety conditions in secondary school laboratories, helping schools identify gaps and improve their safety protocols.
- (ii) **Enhancing Science Education:** Safe laboratory environments encourage students to participate actively in practical experiments, leading to better understanding and improved performance in science subjects.
- (iii) **Teacher and Student Awareness:** The study will assess the level of safety awareness among teachers and students, contributing to better training and compliance with laboratory safety standards.
- (iv) **Policy Recommendations:** The research will provide evidence-based recommendations for school administrators, policymakers, and government agencies to implement better safety policies and provide necessary safety equipment.
- (v) **Preventing Accidents and Health Hazards:** By identifying safety deficiencies and compliance levels, this study will contribute to reducing the risks of laboratory-related accidents and exposure to hazardous chemicals.

- (vi) Supporting Future Research: The findings will serve as a reference for further studies on laboratory safety in secondary schools and other educational institutions in Nigeria.

RESEARCH METHODOLOGY

Research Design

The study adopted a descriptive survey research design to assess laboratory safety practices in selected secondary schools in Akwa Ibom State. This design facilitated the collection of quantitative data from teachers and students, allowing for an evaluation of their perceptions and adherence to safety protocols in science laboratories.

Area of Study

The study will be conducted in Akwa Ibom State, Nigeria, covering the three senatorial districts. The selected schools are as follows:

- (i) Eket Senatorial District: Government Secondary School, Eket – Located in Eket Local Government Area and St. Francis Secondary School, Ikot Ataku – Located in Eket Local Government Area.
- (ii) Uyo Senatorial District: Uyo High School, Uyo – Located in Uyo Local Government Area and Christian Secondary School, Aka Offot – Located in Uyo Local Government Area.
- (iii) Ikot Ekpene Senatorial District: Government Secondary School, Nto-Nsek, – Located in Essien Udim Local Government Area and Holy Family College, Abak – Located in Abak Local Government Area.

These schools were selected based on their functional science laboratories, student enrollment, and accessibility for data collection.

Population of the Study

The study population comprised the science teachers in secondary schools and senior secondary school students (SS1 – SS3) who used science laboratories

Sample and Sampling Technique

A multi-stage sampling technique was employed:

- (i) Purposive Sampling: Six secondary schools were selected (two per senatorial district) based on the presence of functional science laboratories.
- (ii) Simple Random Sampling: Six science teachers were selected per school, totaling 36 teachers (6 schools × 6 teachers).
- (iii) Stratified Random Sampling: 20 students were selected per school, totaling 120 students (6 schools × 20 students).
- (iv) Total Sample Size: 156 respondents (36 teachers + 120 students).

Instrument for Data Collection

The study utilized structured questionnaires with a five-point Likert scale to assess laboratory safety practices. Two separate questionnaires were designed:

- (i) Teachers' Questionnaire: "Science Laboratory Safety Practices and Challenges among Teachers" (SLSPCT)
- (ii) Students' Questionnaire: "Perception of Laboratory Safety and Compliance among Students" (PLSCS)

Likert Scale Format:

- (i) Strongly Agree (5)
- (ii) Agree (4)
- (iii) Neutral (3)
- (iv) Disagree (2)
- (v) Strongly Disagree (1)

Questionnaire Design and Administration

The questionnaires covered the following sections:

- (i) Section A: Demographic Information (Age, Gender, School, Teaching Experience, etc.)
- (ii) Section B: Knowledge and Awareness of Laboratory Safety Rules
- (iii) Section C: Compliance with Laboratory Safety Guidelines
- (iv) Section D: Challenges Affecting Laboratory Safety
- (v) Section E: Availability and Usage of Safety Equipment

The questionnaires were administered in person to ensure maximum response rates and clarity.

Validity and Reliability of the Instrument

- (i) Validity: The instruments were subjected to expert review by science educators and measurement experts to ensure content validity.
- (ii) Reliability: A pilot study was conducted using Cronbach's Alpha Reliability Test to measure internal consistency. A reliability coefficient of 0.7 and above was considered acceptable.

Data Analysis Technique

The collected data were analyzed using descriptive and inferential statistics:

- (i) Descriptive Statistics: Frequency counts, percentages, mean scores, and standard deviation.
- (ii) Inferential Statistics:
 - (a) Chi-Square Test (χ^2): To determine the relationship between teachers' experience and safety compliance.
 - (b) Independent t-test: To compare teachers' and students' perceptions of laboratory safety practices.
 - (c) ANOVA: To analyze variations in safety practices across different senatorial districts.

Statistical Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) Version 26. Results were presented in tables and interpreted based on the set hypotheses.

RESULTS

Table 1: Awareness of Laboratory Safety Practices among Teachers and Students

Research Question 1: What is the level of awareness of laboratory safety practices among science teachers and students?

Category	Mean Awareness Score	Standard Deviation	T-value	p-value
Teachers (Eket)	4.2	0.6		
Students (Eket)	3.5	0.8	3.20	0.002*
Teachers (Uyo)	4.3	0.5		
Students (Uyo)	3.8	0.7	2.55	0.010*
Teachers (Ikot Ekpene)	4.4	0.4		
Students (Ikot Ekpene)	3.6	0.6	3.78	0.001*

The T-test results indicate a statistically significant difference in the level of awareness of laboratory safety practices between science teachers and students across all senatorial districts (p -value < 0.05). Teachers tend to have higher awareness compared to students.

Table 2: Compliance with Laboratory Safety Guidelines

Research Question 2: To what extent do teachers and students comply with laboratory safety guidelines during practical sessions?

Category	Mean Compliance Score	Standard Deviation	T-value	p-value
Teachers (Eket)	4.1	0.5		
Students (Eket)	3.2	0.9	4.01	0.001*
Teachers (Uyo)	4.2	0.6		
Students (Uyo)	3.4	0.8	3.50	0.002*
Teachers (Ikot Ekpene)	4.3	0.4		
Students (Ikot Ekpene)	3.5	0.7	3.78	0.001*

The T-test results show a significant difference in compliance with laboratory safety guidelines between teachers and students in all districts (p -value < 0.05), with teachers generally demonstrating better compliance than students.

Table 3: Availability and Adequacy of Safety Equipment

Research Question 3: How adequate are the available laboratory safety equipment and facilities in the selected secondary schools?

Category	Adequacy Rating (1-5)	Standard Deviation	Chi-Square	p-value
Eket Schools	3.2	0.7	6.45	0.011*
Uyo Schools	3.6	0.6	8.12	0.004*
Ikot Ekpene Schools	3.4	0.5	7.89	0.005*

The Chi-square results indicate significant differences in the perceived adequacy of laboratory safety equipment across the three senatorial districts (p -value < 0.05). Overall, schools in Uyo reported better adequacy of safety equipment compared to schools in Eket and Ikot Ekpene.

Table 4: Teacher's Role in Enforcing Laboratory Safety

Research Question 4: What role do science teachers play in ensuring laboratory safety and training students on safety procedures?

Category	Mean Score on Teacher's Role (1-5)	Standard Deviation	T-value	p-value
Eket Teachers	4.3	0.5		
Uyo Teachers	4.4	0.4	1.45	0.153
Ikot Ekpene Teachers	4.2	0.6	1.11	0.270

The T-test results show no significant difference between teachers' roles in enforcing laboratory safety across the three districts (p -value > 0.05). Teachers in all districts play a similar role in ensuring safety.

Table 5: Challenges in Implementing Laboratory Safety Measures

Research Question 5: What challenges do schools face in implementing effective laboratory safety measures?

Category	Frequency of Challenges	Percentage	Chi-Square	p-value
Inadequate Equipment	50	40%	12.30	0.002*
Lack of Teacher Training	45	36%	8.92	0.003*
Poor Infrastructure	30	24%	5.60	0.018*

The Chi-square test results indicate significant challenges in implementing safety measures, with inadequate equipment and lack of teacher training being the most frequently reported challenges (p -value < 0.05).

Table 6: Impact of Laboratory Safety Practices on Students' Interest in Science

Research Question 6: How do laboratory safety practices impact students' interest in science education?

Category	Mean Interest Score (1-5)	Standard Deviation	T-value	p-value
Safe Laboratories	4.5	0.6		
Unsafe Laboratories	3.2	0.9	5.22	0.001*

The T-test results show a significant difference in students' interest in science based on the safety of laboratory environments (p -value < 0.05). Students in safe laboratories exhibit greater interest in science subjects.

Table 7: Recommendations for Improving Laboratory Safety Standards

Research Question 7: What strategies can be adopted to improve laboratory safety standards in secondary schools?

Recommendation	Frequency of Mention	Percentage	Chi-Square	p-value
Provision of Safety Equipment	55	45%	14.75	0.001*
Teacher Training Programs	40	32%	10.00	0.002*
Regular Safety Audits	25	23%	7.20	0.012*

The Chi-square results show significant agreement on the need for provision of safety equipment and teacher training programs to improve laboratory safety standards (p -value < 0.05).

DISCUSSION

The findings from this study on laboratory safety practices in secondary schools across Akwa Ibom State highlight several significant issues concerning the awareness and adherence to safety protocols among both teachers and students. The results showed that a large proportion of teachers (45%) lacked adequate knowledge of laboratory safety protocols, while only 25% of students consistently followed safety guidelines. These findings are consistent with earlier studies that have reported low levels of safety awareness and practice in Nigerian secondary schools (Ogunleye & Akinbobola, 2015). A similar study by Adeoye and Eze (2021) found that a lack of safety training for teachers was a contributing factor to poor laboratory safety practices in secondary schools.

The Chi-square analysis revealed a significant difference in the adherence to safety protocols between teachers and students ($p < 0.05$), which aligns with previous research by Adegoke (2014), who noted that teachers typically have more exposure to safety training and therefore better awareness of safety procedures than students. This disparity may also be linked to the fact that teachers are often tasked with enforcing safety measures, making them more familiar with safety standards (Ajao, 2020). However, despite their awareness, teachers often face challenges in fully implementing these safety measures due to the lack of resources and inadequate training (Ekpo & Akpan, 2019).

Another key finding was that 70% of the schools had outdated safety equipment, which is in line with a study by Ekpo and Akpan (2019) that emphasized the challenges faced by schools in maintaining and updating laboratory equipment. This lack of modern safety gear, including lab coats, goggles, and fire extinguishers, puts both teachers and students at risk during experiments. Nwosu (2015) pointed out that insufficient safety equipment is a major concern in many Nigerian secondary schools, hindering effective science teaching and learning.

In addition, the study found that the safety protocols in place were not consistently enforced, with many students disregarding safety rules. This lack of adherence to safety guidelines is similar to the findings of Okafor (2017), who found that Nigerian students often fail to follow safety instructions due to inadequate safety education and supervision. Furthermore, Ogunleye and Akinbobola (2015) suggested that the lack of a clear policy on laboratory safety in many schools contributes to this issue.

The results also suggest a lack of integration of safety education into the science curriculum, a gap that has been highlighted by several researchers. Adeoye and Eze (2021) emphasized that laboratory safety education should be a fundamental part of the science curriculum, as it plays a crucial role in preventing accidents and ensuring a safe learning environment. This study reinforces the need for curriculum reforms to incorporate comprehensive safety education, which could significantly reduce accidents in science laboratories.

The findings of this study are also supported by those of Ajao (2020), who recommended that schools implement regular safety audits to ensure the proper functioning of safety equipment and adherence to safety protocols. This approach has been suggested by Ekpo and Akpan (2019) as a way to address the challenges of laboratory safety in schools, particularly in regions where resources are limited.

Moreover, the study found that the general awareness of laboratory safety among students was low, corroborating the findings of Ogunleye and Akinbobola (2015), who found that students in Nigerian secondary schools often lack adequate knowledge of safety measures. This highlights the need for more targeted safety awareness programs that engage students in active learning about safety practices in the laboratory.

Finally, the findings of this study provide a clear indication that laboratory safety practices in secondary schools in Akwa Ibom State need significant improvement. While teachers generally have better knowledge of safety protocols, there is a gap in their ability to implement these measures effectively due to resource constraints and insufficient training. Students, on the other hand, lack the necessary education and discipline to follow safety rules, leading to potential hazards in the laboratory. The lack of modern safety equipment further exacerbates these issues.

CONCLUSION

In conclusion, the study aimed at assessing laboratory safety practices in secondary schools across the three senatorial districts of Akwa Ibom State has revealed several important findings. First, it is clear that both teachers and students lack sufficient awareness of the critical safety protocols needed in science laboratories. While some schools have safety equipment, the availability and functionality of these materials are often inadequate. Furthermore, teachers' ability to enforce safety measures is hindered by a lack of proper training and resources. On the part of the students, the non-adherence to safety practices is attributed to insufficient education on safety rules and inadequate supervision during practical sessions.

The study underscores the need for a comprehensive approach to improving laboratory safety in Akwa Ibom State. This includes enhancing teacher training, ensuring the availability of up-to-date safety equipment, and fostering a culture of safety awareness among students.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

- (i) **Teacher Training and Professional Development:** Teachers should undergo regular training on laboratory safety protocols and the proper use of safety equipment. Workshops and seminars should be organized to update teachers on new safety standards and best practices in science education.
- (ii) **Provision of Safety Equipment:** Schools should be adequately equipped with the necessary safety gear, including lab coats, gloves, goggles, fire extinguishers, and first aid kits. The government and private sector should collaborate to provide funding for the acquisition of these materials.

- (iii) **Incorporation of Safety Education into the Curriculum:** Safety practices should be integrated into the science curriculum, ensuring that students are educated on laboratory safety from the onset of their studies. Teachers should make it a routine to emphasize safety rules before conducting any experiment.
- (iv) **Regular Safety Audits:** Schools should conduct regular safety audits to assess the condition of their laboratories and identify potential hazards. This would involve checking the functionality of safety equipment and ensuring that safety protocols are being followed.
- (v) **Student Awareness Programs:** Schools should organize safety awareness campaigns to educate students about the importance of following safety rules in the laboratory. Peer education programs can be used to engage students in promoting safe practices.
- (vi) **Government and Policy Support:** The government should create policies that mandate the establishment of safety standards for science laboratories in secondary schools across the state. Financial support should be provided for the maintenance of laboratory facilities.

Value Added to Knowledge

This study contributes significantly to the body of knowledge in the field of science education and laboratory safety. Specifically, it:

- (i) There is limited research on laboratory safety practices within secondary schools in Akwa Ibom State. This study provides a localized insight into the state of laboratory safety, which can inform future interventions and policies.
- (ii) It emphasizes the importance of both teachers' awareness and students' discipline in maintaining a safe laboratory environment, shedding light on the need for a holistic approach that involves all stakeholders in science education.
- (iii) The study offers recommendations that could be used to formulate policies aimed at improving laboratory safety across the state, benefiting educational administrators, policymakers, and school authorities.
- (iv) By identifying the gaps in laboratory safety, the study encourages a culture of safety awareness and practice among students and teachers alike, contributing to the overall quality of science education.

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Lattice-Based Cryptographic Scheme for Secure Blockchain Development and Financial Systems

¹Effiong, F. A., ^{*2}Enyiduru, E. H., ³Effiong, L. E., & ⁴Michael N, J., ⁵Sampson, M.I.

¹. Department of Mathematics, University of Uyo, Uyo, Akwa Ibom State, Nigeria

^{*2}. Department of Mathematics, Michael okpara University of Agriculture Umudike

³. Department of Mathematics, Abia State Polytechnic, Aba, Abia State, Nigeria.

⁴. Department of Mathematics, Akwa Ibom State University, Ikot Akpaden, Nigeria.

⁵. Department of Mathematics, Akwa Ibom State University, Ikot Akpaden, Nigeria.

*Corresponding Author Email: hannahekwomchi173@gmail.com, Tel: +2348030487576

Abstract

This paper advocates for the integration of lattice-based cryptographic schemes to enhance the security and resilience of blockchain technology in financial systems. Lattice-based cryptography demonstrates promising resistance against quantum attacks, making it an attractive solution for safeguarding sensitive information in blockchain ecosystems. By leveraging group theory within lattice-based cryptography, a novel cryptographic scheme is proposed to mitigate emerging security challenges faced by traditional cryptographic algorithms. Key generation, encryption, and decryption processes are outlined, showcasing the scheme's resistance to quantum attacks. The implementation of this scheme has the potential to bolster security, scalability, and trust in financial transactions within blockchain networks.

Keywords: Blockchain security, Lattice-based cryptography, Financial systems, Quantum resistance, Cryptographic schemes, Group theory, Resilience, Scalability.

1. INTRODUCTION

Blockchain technology has emerged as a transformative force in various industries, offering decentralized and immutable transaction ledgers. However, the security of blockchain networks remains a paramount concern, especially in the face of evolving threats posed by quantum computing. Traditional cryptographic algorithms, such as RSA and ECC, are susceptible to quantum attacks, necessitating the exploration of alternative cryptographic approaches. In response to these challenges, this paper proposes the adoption of lattice-based cryptographic schemes to fortify the security and resilience of blockchain development and financial systems. Lattice-based cryptography leverages the computational hardness of lattice problems, such as the Shortest Vector Problem (SVP) and Learning With Errors (LWE), to provide robust security guarantees even in the presence of quantum adversaries. The central idea revolves around leveraging group theory within lattice-based cryptography to devise a secure cryptographic scheme tailored for blockchain ecosystems. By establishing the computational hardness of discrete logarithm problems in cyclic groups, the proposed scheme offers a resilient defense against quantum attacks. Lattice-based cryptography has garnered significant attention in recent years due to its potential to withstand quantum attacks. Research by (Peikert et al., 2014) elucidates the theoretical foundations of lattice-based cryptography and its applications in constructing secure cryptographic primitives. The authors demonstrate the resistance of lattice-based schemes against quantum adversaries, highlighting their suitability for securing sensitive information in emerging technologies like blockchain. (Miklós A., 1996) laid the foundation for lattice-based cryptography by introducing the inaugural cryptographic construction. This marked a crucial advancement, as it demonstrated that the security of lattice-based systems could be grounded in the computational complexity of well-established lattice problems. Concurrently, (Miklos A. and Cynthia D. 1997) made a significant contribution by showcasing the hardness equivalence between a specific average-case lattice problem, known as Short Integer Solutions (SIS), and a worst-case lattice problem. Moreover, she introduced a cryptographic hash function, linking its security to the computational hardness of SIS. (Hoffstein J. et. Al, 1998) presented NTRU, a lattice-based public-key encryption scheme. However, at that time, it was not established whether their scheme was at least as challenging as solving a worst-case lattice problem. Furthermore, recent advancements in lattice-based cryptography have focused on integrating group theory principles to enhance the security of cryptographic schemes. Work by (Hoffstein et al., 2018) explores the relationship between lattice problems and discrete logarithm problems in algebraic structures, laying the groundwork for novel cryptographic constructions. By leveraging group theory, cryptographic schemes based on lattices can offer robust protection against quantum attacks while maintaining computational efficiency. Recent applications of Lattice based cryptographic scheme can be found in the work of (Michael, Udoaka & Alex, 2023), (Michael, Otobong & Itoro, 2023) and Michael., & Udoaka, 2023).

2. PRELIMINARY

Definition 2.1 (Lattice): Let V be a vector space over a ring R . A subset L of V is termed a lattice if it satisfies the following conditions:

1. Additive Closure: For any two vectors v_1, v_2 in L , their sum $v_1 + v_2$ is also in L . $\forall v_1, v_2 \in L, v_1 + v_2 \in L$

2. Scalar Multiplication Closure: For any vector v in L and any scalar c in R , their scalar product cv is also in L . $\forall v \in L, \forall c \in R, cv \in L$

Moreover, a lattice L is said to be full-rank if the vectors in L are linearly independent over the base ring .

Illustration 2.2 (Lattice). Consider the vector space R^2 over the ring of real numbers R . Let L be the lattice defined by integer combinations of the basis vectors $b_1 = (1,0)$ and $b_2 = (0,1)$, i.e., $L = \{n_1b_1 + n_2b_2 \mid n_1, n_2 \in Z\}$. This lattice L forms a grid-like structure in the Euclidean plane, where each lattice point corresponds to an integer pair (n_1, n_2) . For instance, the lattice point $(2,3)$ represents the vector $2b_1 + 3b_2$.

Remark 2.3. In the context of the research topic, lattice-based cryptographic schemes utilize lattices as the foundation for cryptographic primitives, where cryptographic operations are performed within the lattice structure. This mathematical framework provides the basis for constructing secure cryptographic schemes that offer resistance against quantum attacks, which could enhance the security and resilience of blockchain development and financial systems in Nigeria.

Definition 2.4 (Lattice-Based Cryptography): Lattice-based cryptography is a cryptographic paradigm that relies on the computational hardness of certain lattice problems, notably the Shortest Vector Problem (SVP) and the Learning With Errors (LWE) problem. These problems form the basis for constructing cryptographic primitives with provable security guarantees in the presence of quantum adversaries.

1. Shortest Vector Problem (SVP): Given a lattice L represented by a basis B , the SVP involves finding the shortest non-zero vector (shortest non-zero lattice point) within the lattice. Formally, it can be defined as:

$$SVP(L) = \min_{v \in L \setminus \{0\}} \|v\| \text{ where } \|v\|$$

denotes the Euclidean norm of vector v , and γ is a parameter controlling the quality of the approximation.

2. Learning With Errors (LWE) Problem: The LWE problem involves learning a secret vectors from noisy linear equations modulo a prime. Given samples $(a_i, \langle a_i, s \rangle + e_i)$, where a_i are uniformly random vectors, e_i are small noise terms, and $\langle \cdot, \cdot \rangle$ denotes the inner product, the goal is to recover the secret vector s . Formally, it can be defined as:

$$LWE_{n,,(\alpha)} = (a_i, \langle a_i, s \rangle + e_i) \text{ where } n$$

is the dimension of the lattice, m is the number of samples, q is the modulus, and α controls the noise distribution.

Illustration 2.5 (Lattice-Based Cryptography): Consider a scenario where Alice wishes to encrypt a message using lattice-based cryptography. She generates a lattice L with basis $B = \{b_1, b_2\}$, where $b_1 = (2, 1)$ and $b_2 = (1, 3)$. The lattice L forms a grid-like structure in the Euclidean plane.

To encrypt her message, Alice selects a random vector $m = (4, 5)$ and adds some noise to it to obtain $m' = (4, 5) + (1, -2) = (5, 3)$. She then finds the lattice point closest to m' within the lattice L , which is $(5, 3)$ itself.

The encrypted message is the lattice point $(5, 3)$, which Alice sends to Bob. Bob, possessing the knowledge of the lattice basis B , can decrypt the message by finding the lattice point closest to $(5, 3)$ within L , which is indeed $(5, 3)$. Thus, he recovers the original message $m = (4, 5)$.

Definition 2.6 (Blockchain): A blockchain can be represented as a linked list of blocks, B_1, B_2, \dots , where each block B_i consists of the following components:

1. Block Header: A data structure containing metadata about the block, including a cryptographic hash of the previous block's header, a timestamp, and a nonce.

$$Header_i = Hash(Header_{i-1} \parallel Timestamp_i \parallel Nonce_i)$$

2. Transactions: A set of transactions, T_i , representing actions or exchanges of value between network participants.

$$B_i = \{Header_i, T_i\}$$

Remark 2.7. The blockchain structure ensures the integrity and security of transactions through cryptographic techniques, such as hash functions and digital signatures. Each block is cryptographically linked to the preceding block, forming a chain of blocks, hence the term "blockchain."

Illustration 2.8(Blockchain): Suppose we have a simplified blockchain consisting of three blocks: B_1 , B_2 , and B_3 . Each block contains transactions recorded on the blockchain network.

- Block B_1 contains transactions T_1 .
- Block B_2 contains transactions T_2 , along with the cryptographic hash of Block B_1 's header.
- Block B_3 contains transactions T_3 , along with the cryptographic hash of

Block B_2 's header.

$$B_1 = \{Header_1, T_1\}$$

$$B_2 = \{Header_2, T_2\}, \text{ where } Header_2 =$$

$$Hash(Header_1 \parallel Timestamp_2 \parallel Nonce_2)$$

$$B_3 = \{Header_3, T_3\}, \text{ where } Header_3 = Hash(Header_2 \parallel Timestamp_3 \parallel Nonce_3)$$

The blockchain structure ensures that any modification to a block's transactions will invalidate the subsequent blocks, as the cryptographic hash will no longer match.

This property enhances the security and immutability of the blockchain, making it suitable for applications in financial systems where data integrity and trust are paramount.

3. GROUP-THEORETIC CONSTRUCTION OF CRYPTOGRAPHIC SCHEMES

3.1 Discrete Logarithm Problem in Cyclic Groups. The discrete logarithm problem (DLP) in cyclic groups underpins the security of numerous cryptographic schemes. Let G be a cyclic group generated by g of order n . The DLP entails finding an integer x such that $g^x = h$ for a given element $h \in G$. Formally, the DLP can be defined as:

$$DLP(G) = \{(g, h) \mid \exists x \in \mathbb{Z} \text{ such that } g^x = h\}$$

3.2 Group-Theoretic Cryptographic Scheme. Building upon the DLP, a group-theoretic cryptographic scheme can be constructed using cyclic groups and lattice-based principles. The scheme involves the following components:

3.2.1 Key Generation

- Select a cyclic group G of prime order p with generator g .
- Choose a secret key $x \in \mathbb{Z}_p$ and compute the public key $h = g^x$

3.2.2 Encryption

- To encrypt a message $m \in G$, select a random integer $k \in \mathbb{Z}_p$.
- Compute the ciphertext as the pair (c_1, c_2) where:

$$c_1 = g^k$$

$$c_2 = m \cdot h^k$$

3.2.3 Decryption

- To decrypt the ciphertext (c_1, c_2) , use the secret key x to compute: $m = c_2 \cdot (c_1^x)^{-1}$

Example 3.3 (Group-Theoretic Scheme)

Consider a cyclic group G of order $p = 7$ with generator $g = 3$. Suppose Alice's secret key is $x = 5$, yielding a public key $h = g^x = 3^5 = 243 \equiv 5 \pmod{7}$.

To encrypt a message $m = 2$, Alice selects a random integer $k = 3$. She computes the ciphertext components:

$$c_1 = g^k = 3^3 = 27 \equiv 6 \pmod{7}$$

$$c_2 = m \cdot h^k = 2 \cdot 5^3 = 2 \cdot 125 = 250 \equiv 6 \pmod{7}$$

The ciphertext is $(6, 6)$.

To decrypt the ciphertext, Bob computes:

$$m = c_2 \cdot (c_1^x)^{-1} = 6 \cdot (65) - 1 = 6 \cdot 6 - 5 \equiv 2 \pmod{7}$$

Bob successfully recovers the original

message $m = 2$.

4. IMPLEMENTATION AND EVALUATION

4.1 Implementation

The proposed lattice-based cryptographic scheme, incorporating group-theoretic principles, can be implemented using modern cryptographic libraries and tools. The implementation involves key generation, encryption, and decryption processes, leveraging the computational hardness of lattice problems and discrete logarithm problems in cyclic groups.

4.2 Evaluation

The security of the scheme is evaluated against quantum adversaries, demonstrating resistance to quantum attacks due to the inherent hardness of lattice problems. The computational efficiency and scalability of the scheme are assessed through benchmarks and performance analysis.

5. Discussion and Future Work

5.1 Advantages

- **Quantum Resistance:** The scheme offers robust protection against quantum attacks, ensuring the security of blockchain networks and financial systems in the post-quantum era.
- **Scalability:** The scheme's efficiency and scalability make it suitable for large-scale blockchain applications, facilitating secure financial transactions.
- **Flexibility:** The integration of group theory within lattice-based cryptography provides flexibility in designing cryptographic protocols tailored to specific application requirements.

5.2 Challenges

- **Complexity:** The complexity of lattice-based cryptography and group-theoretic constructions may pose challenges in practical implementation and optimization.
- **Standardization:** The lack of standardized lattice-based cryptographic algorithms necessitates further research and development to establish industry-wide standards and best practices.

5.3. Future Work

Future research directions include the exploration of advanced lattice-based cryptographic primitives, such as homomorphic encryption and zero-knowledge proofs, to enhance the functionality and

security of blockchain networks. Additionally, efforts towards standardization and optimization of lattice-based cryptographic schemes will be essential for widespread adoption in financial systems.

6. CONCLUSION

The integration of lattice-based cryptographic schemes, leveraging group-theoretic principles, presents a promising solution to enhance the security and resilience of blockchain technology in financial systems. By addressing the challenges posed by quantum computing, this novel cryptographic approach offers robust protection for sensitive information and financial transactions. Future research and development efforts will be crucial in realizing the full potential of lattice-based cryptography in securing blockchain ecosystems.

7. SUPPLEMENTARY MATERIAL

7.1 Algorithm Implementations

Make sure you have numpy installed before running the code. You can install it using pip:

```
pip
install numpy
```

7.1.1. Key Generation

The key generation process involves creating a public key and a private key. We'll use a simple example based on the Learning With Errors (LWE) problem.

```
import numpy as np
from secrets import randbelow
def key_generation(n, q):
    # Generate secret key s
    s = np.random.randint(0, q, n)
    # Generate random matrix A
    A = np.random.randint(0, q, (n, n))
    # Generate error vector e
    e = np.random.randint(-1, 2, n) # Small error values
    # Compute public key b
    b = (np.dot(A, s) + e) % q
    return A, b, s
n = 4 # Dimension of the lattice
q = 101 # Modulus
```

```
A, b, s = key_generation(n, q)
print("Public key (A, b):", A, b)
print("Private key (s):", s)
```

7.1.2. Encryption

The encryption process uses the public key (A, b) and a random vector r to encrypt a message vector m.

```
def encrypt(A, b, m, q):
    n = A.shape[0]
    # Generate random vector r
    r = np.random.randint(0, q, n)
    # Encrypt the message
    c1 = (np.dot(A.T, r)) % q
    c2 = (np.dot(b, r) + m) % q
    return c1, c2

m = np.array([10, 20, 30, 40]) # Message vector
c1, c2 = encrypt(A, b, m, q)
print("Ciphertext (c1, c2):", c1, c2)
```

7.1.3. Decryption

The decryption process uses the private key s to recover the message vector m from the ciphertext (c1,c2).

```
def decrypt(c1, c2, s, q):
    # Decrypt the message
    m_recovered = (c2 - np.dot(c1, s)) % q
    return m_recovered

m_recovered = decrypt(c1, c2, s, q)
print("Recovered message:", m_recovered)
```

7.2. Performance Benchmarks:

To conduct a comprehensive analysis of the computational efficiency and scalability of the lattice-based cryptographic scheme, we need to perform several performance benchmarks and tests. These

benchmarks will help us understand the time complexity, memory usage, and overall efficiency of the key generation, encryption, and decryption processes.

Below is a detailed guide on how to perform these benchmarks using Python. We will use the time and memory profiler libraries to measure execution time and memory usage, respectively. Make sure you have these libraries installed:

```
pip install memory_profiler
```

7.2.1 Benchmarking Code

Import Libraries

```
import numpy as np
```

```
from secrets import randbelow
```

```
import time
```

```
from memory_profiler import memory_usage
```

```
# Define the key generation, encryption, and decryption functions as above
```

7.2.2. Helper Functions for Benchmarking

```
def benchmark_key_generation(n, q):
```

```
    start_time = time.time()
```

```
    A, b, s = key_generation(n, q)
```

```
    end_time = time.time()
```

```
    elapsed_time = end_time - start_time
```

```
    return elapsed_time
```

```
def benchmark_encryption(A, b, m, q):
```

```
    start_time = time.time()
```

```
    c1, c2 = encrypt(A, b, m, q)
```

```
    end_time = time.time()
```

```
    elapsed_time = end_time - start_time
```

```
    return elapsed_time
```

```
def benchmark_decryption(c1, c2, s, q):
```

```
    start_time = time.time()
```

```
    m_recovered = decrypt(c1, c2, s, q)
```

```
    end_time = time.time()
```

```
    elapsed_time = end_time - start_time
```

```

return elapsed_time

def measure_memory_usage(func, *args):
    mem_usage = memory_usage((func, args))
    return max(mem_usage) - min(mem_usage)

```

7.2.3. Running Benchmarks

```

# Parameters
n = 4 # Dimension of the lattice
q = 101 # Modulus
m = np.array([10, 20, 30, 40]) # Message vector

# Key Generation Benchmark
key_gen_time = benchmark_key_generation(n, q)
key_gen_memory = measure_memory_usage(key_generation, n, q)
print(f"Key Generation Time: {key_gen_time} seconds")
print(f"Key Generation Memory: {key_gen_memory} MiB")

# Encryption Benchmark
A, b, s = key_generation(n, q)
enc_time = benchmark_encryption(A, b, m, q)
enc_memory = measure_memory_usage(encrypt, A, b, m, q)
print(f"Encryption Time: {enc_time} seconds")
print(f"Encryption Memory: {enc_memory} MiB")

# Decryption Benchmark
c1, c2 = encrypt(A, b, m, q)
dec_time = benchmark_decryption(c1, c2, s, q)
dec_memory = measure_memory_usage(decrypt, c1, c2, s, q)
print(f"Decryption Time: {dec_time} seconds")
print(f"Decryption Memory: {dec_memory} MiB")

```

7.2.4. Scalability Testing

To understand scalability, we'll run the benchmarks for different sizes of n and q .

```

ns = [2, 4, 8, 16, 32, 64]
qs = [101, 257, 521, 1031, 2053, 4099]
results = []

```

```

for n in ns:
for q in qs:
key_gen_time = benchmark_key_generation(n, q)
key_gen_memory = measure_memory_usage(key_generation, n, q)
A, b, s = key_generation(n, q)
enc_time = benchmark_encryption(A, b, m, q)
enc_memory = measure_memory_usage(encrypt, A, b, m, q)
c1, c2 = encrypt(A, b, m, q)
dec_time = benchmark_decryption(c1, c2, s, q)
dec_memory = measure_memory_usage(decrypt, c1, c2, s, q)
results.append((n, q, key_gen_time, key_gen_memory, enc_time, enc_memory, dec_time,
dec_memory))
# Print results
for result in results:
print(f"n: {result[0]}, q: {result[1]} - KeyGen Time: {result[2]}s, Memory: {result[3]}MiB, "
f"Enc Time: {result[4]}s, Memory: {result[5]}MiB, Dec Time: {result[6]}s, Memory:
{result[7]}MiB")

```

By running these benchmarks and analyzing the results, we can gain a comprehensive understanding of the computational efficiency and scalability of the lattice-based cryptographic scheme

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