JOURNAL OF RESEARCH IN SCIENCE EDUCATION (JORISE)

Vol. 5, Issue 1 October 2025

JOURNAL OF RESEARCH IN SCIENCE EDUCATION (JORISE)

A PUBLICATION OF

DEPARTMENT OF SCIENCE EDUCATION
FACULTY OF EDUCATION, EKITI STATE UNIVERSITY,
ADO-EKITI, NIGERIA

ISSN: 2545 – 5788

VOL. 5, ISSUE 1 OCTOBER 2025

Printed in Nigeria by:
SOD Creativity
Tel: (+234) 8167335609
E-mail: sodcreativity5@gmail.com

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EDITORIAL

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Thank you to all contributors, reviewers, and readers for the successful production of this edition. Their engagement strengthens science education globally, while I solicit for continued support for future production.

O. I. Oginni Ph.D

Editor-in-Chief

TABLE OF CONTENTS

CLASSROOM VERBAL INTERACTION AND STUDENTS' ACADEMIC PERFORMANCE IN SECONDARY SCHOOL PHYSICS IN EKITI STATE

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Abstract

The study investigated the classroom verbal interaction (CVI) and students' academic performance in Secondary School Physics in Ekiti State. The study investigated the effectiveness of CVI and conventional teaching methods on the academic performance of Secondary School Students in Physics was examined. The study adopted quasi – experimental pre-test, post-test two groups (one experimental and one control) research design. The sample consisted of 157 SSS 1 students (intact class) drawn from four public senior secondary schools in Ekiti Central Senatorial District of Ekiti State, Who were selected using multistage sampling procedure. A research instrument- "Physics performance Test" (PPT) was used to collect relevant data for the study. The face and content validity of the instrument was ensured while the reliability of the instrument was ascertained using note method; Pearson's Product Moment Correlation Analysis and Spearman Brown Prophecy formula which yielded reliability co-efficient of 0.847. The data were analyzed using descriptive statistics (mean and standard deviation) and inferential statistics of t-test at 0.05 level of significance. The findings of the study showed that the use of Classroom Verbal Interaction enhanced the performance of students in Physics than the conventional strategy, the use of Classroom Verbal Interaction are not gender and location biased. Based on the findings, it was recommended among others that the use of Classroom Verbal Interaction should be encouraged in teaching Physics the teachers should be given adequate orientation through workshops and seminars to update their knowledge in the use of Classroom Verbal Interaction strategy.

Key words: Classroom interaction, conventional strategy, verbal interaction, learning, teaching.

Introduction

Science has been conceptualized as one of the greatest and most influential field of study. As a whole, science helps to gain a better understanding of the universe, our planet, ourselves, and other living things. Depending on the subject matter, science may be broken down into a variety of subfields; Astronomy, Physics, Chemistry, and the Earth Sciences are all fields of physical science that study the inorganic universe. The social and cultural aspects of human conduct are examined in several social sciences. Science has

become a vital part of daily life in modern culture. Aspirations for the next generation could be jeopardized if they do not pay attention to scientific innovations. Therefore, it is important to point out that a country's growth is heavily dependent on the level of scientific literacy in its population.

One of the goals of national education policy is to produce individuals who are well-versed in a wide range of scientific disciplines. The goals and objectives of Nigeria's education policy explicitly state that the learner could acquire basic practical skills for self-reliance and employment. Science students in Nigeria's Senior Secondary Schools must take Physics as part of their curriculum as it is one of the requisite science subjects that must be passed to study science-related courses in higher institutions (Oladejo, Okebukola, Akinola and Amusa 2023). The importance of Physics in scientific and technological endeavours cannot be overemphasized. Bada and Jita (2021), the study of Physics is one of the most important subjects for secondary school science students. Some countries, like China, have become more advanced economically due to their exceptional knowledge of science and technology. For Nigeria as a developing country to be more advance, the developments in Nigerian science and technology are crucial and should not be neglected. Achieving this goal requires the incorporation of scientific curriculum principles, with a concentration on Physics in particular (Chala, 2019).

In Nigeria, Physics is one of the branches of science taught in high schools. The study of matter and its motion through time, as well as concepts like energy and force, are only a few of the numerous facets of physical science. A well-executed Physics curriculum may help students to keep up with the latest developments in the area of Physics. Physics as a scientific field involves studies into the properties of matter and its interactions with energy. The concepts and theories in Physics are important when it comes to comprehending natural phenomena. Many different topics are covered in the study of Physics, which is a major Senior Secondary Science subject. These topics provide the groundwork for further studies in Physics and other related fields. Medical, nursing, pharmacy, food technology, and other areas, all rely on the application of Physics concepts in their skills acquisition.

Stakeholders in Nigeria's education system are very concerned about the low levels of achievement in Physics among the students. There have been many explanations as to why this declining tendency has occurred. Some of the issues found to be responsible for this have been traced to the teachers, which ranges from non-adoption of technology for classroom instruction, use of inappropriate teaching method, inadequate facilities, as well as a high student-to-teacher ratio, lack of confidence in the subject by both students and teachers, approaches used by teachers in teaching the students, low interest in the learning of Physics at all level of education are some of the major causes of this problem (Oginni and Owolabi, 2012; Ayeni, Omotayo & Adedayo, 2016).

Some instructional strategies have been adopted by teachers and researchers in the teaching of Physics which were found not to be yielding the desired results. Most of these strategies are viewed as orthodox or conventional methods by researchers and teachers who follow the trend of development in the pedagogical process (Adedayo, 2015). Most of these strategies are teacher-centered where the teacher dominates the class, making the learners passive, uninvolved, and failing to respect individual differences in the learners and learning characteristics. This makes it difficult to identify the area of weaknesses in the learners which later makes students

view Physics as a difficult subject and thus develop a negative attitude towards the subject which in the long run negatively affects their academic performance. These strategies are not interactive, participatory, and collaborative which may render the objectives unachievable. The traditional approach to education where students receive direct instruction and then practice specific skills is not good enough for critical thinking. (Oyinloye and Popoola, 2013). Teaching could however be meaningfully productive when students are actively involved and responsible for their own learning; this tends to promote positive interaction between both the teacher and the students.

Classroom interaction refers to the series of events that takes place one after the other in classroom, each taking up just a little amount of time. It is also refers to the verbal and non-verbal exchanges between teacher, students and peer in an educational settings. It is a crucial aspect of the learning process, as it fosters academic achievement, social skills and emotional intelligence. Classroom interaction should be a channel for instruction Pujiastuti (2013).

According to Panjaitan, Irma, Sri, and Syarifah (2017), the primary components of verbal interactions are signs and symbols, tone of voice, flushing, while other facial reactions serve as secondary products of the massage that precedes them. It implies that there are several methods to offer a verbal interaction. It is up to the teacher to explain themselves in a manner that allows students to comprehend. Verbal interaction is the use of words and syntax to convey information in a discussion. The process of exchanging information orally is called verbal interaction.

Although, many factors may contribute to a teacher's success in the classroom, student-teacher interaction is likely to be a major factor. The nature and level of teacher-student interaction in the classroom may have a significant impact on the success of instruction and learning. Not only may students' attitudes, interests, and even personalities be shaped by the quality and quantity of classroom interaction, but it may also have a significant impact on how well they learn. Students' personalities and the effectiveness of their education are profoundly influenced by the classroom's psychological climate. Teachers have a great deal of influence over their classroom environment because they have the opportunity to tap into their students' boundless reserves of energy and excitement (Krauss, 2015).

It was stated by Pujiastuti (2013) that students appreciate teachers who make an effort to engage in conversation and empathise with their circumstances in the classroom. Most students feel more at ease and their learning would improve if they are motivated and reinforced equally (evenly), as opposed to classes where teachers do not take into account the weaknesses, emotions, or opinions of students. Cheruiyot (2015) found that verbal interaction has some effects on the performance of the students. In addition to this, he discovered that the ratio of indirect to direct verbal interaction that teachers have with their students is 1:2

Students' performances in secondary school Physics classes have long been thought to be strongly influenced by students' gender while some thought it not to have an influence on students' academic performance. The term "gender" is used to describe the social implications of being a male or a female, such as differences in identity, interests, behaviour, and power (Elejere, 2018). Gender encompasses the full range of male and female characteristics that are either shared by or distinguishable from the general population. The social and cultural differences between males and females are crucial to understanding the

importance of analyzing gender performance. While Ndirika and Agommuoh (2017) reported seeing gender differences in students' thoughts about science and their performance in Physics, Lindner, Makarova, Bernhard, and Brovelli (2022) concluded that there is no substantial difference between male and female students in their thoughts toward Physics and their performance in the subject. Equality and difference in Physics learning outcomes among students have been identified as important study topics for quite some time (Obafemi, 2015).

Students' levels of performance in Physics may also be influenced by other contextual factors, such as their school's geographic location. Learners' thoughts, feelings, and beliefs are susceptible to the surrounding environment. There are schools in both urban and rural regions, and even some schools in urban areas that are so far out of the way that they may as well be seen as rural areas by the untrained individual. Students' academic performance could be significantly affected by their school's geographical location. According to Akinyele (2011), a student's immediate surroundings are crucial to his development as a social being. Hence students' performance in school may be affected by the neighborhood in which their school is situated. Owoleye and Yara (2011) discovered a statistically significant gap in performance between students attending urban and rural schools. However, Yusuf and Adigun (2010) found that students' academic performance was not affected by whether or not they attended a secondary school in a rural or urban setting. Also, Abamba (2021) revealed that secondary school students in both rural and urban areas have similar assertiveness regarding Physics, and as such they are similar in their performance. There was no discernible performance gap between urban and rural school students, as determined by Bosede (2010).

Statement of the Problem

It is important to boost student involvement in classroom activities in order to inspire and push them to study more. There is need to look at the effect of using modern innovative methods to teach Physics. Evidences abound that students' verbal interactions in the classroom could be used to effectively facilitate better performance in Physics. This study is faced with the problem of verifying the effects of Verbal Interaction on students' performance in Physics.

Purpose of the study

The purpose of the study is to examine the effect of Classroom Verbal Interaction (CVI) on the academic performance of Secondary School Students in Physics.

Research Question

Will Classroom Verbal Interaction (CVI) influence Secondary School Students' academic performance in Physics?

Research Hypotheses

1. There is no significant difference in the pre-test performance mean scores of students exposed to Classroom Verbal Interaction (CVI) and conventional method
2. There is no significant difference post-test performance mean scores of students exposed to Classroom Verbal Interaction (CVI) and conventional method

Research Method,

The study adopted pretest, posttest, quasi-experimental two groups (one experimental group and one control group) research design. The targeted population for the study consisted of all the Senior Secondary School (S.S.S.) 1 students in public secondary schools. The sample consisted of 157 S.S.S. 1 students (intact class size) drawn from four public secondary schools. The sample was selected using multistage sampling procedure. The first stage was the selection of a senatorial district from

the three senatorial districts in Ekiti State using simple random sampling technique. The second stage involved the selection of two Local Government Areas from the selected Senatorial District in Ekiti State using simple random sampling technique. The third stage was the selection of two (one rural and one urban) schools from each of the local governments selected, making four (two rural and two urban) mixed schools using stratified sampling technique.

An instrument titled Physics Performance Test (PPT) constructed by the researcher was used for collecting data for the study. The instrument comprised two sections A and B. Section A contained items on the bio-data of the respondents such as school, class, gender and Local Government. Section B contained30 items of multiple-choice questions on topics covered by the study. The instrument (PPT) was validated by experts in Test, Measurement and Evaluation, two experienced secondary school Physics teachers who are NECO and WAEC examiners for both face and content validity. The reliability of the instrument (PPT) was determined using split-half method and a reliability coefficient of 0.847 was obtained

The experimental procedure for the study involved three stages namely: the pre-treatment stage, the treatment stage and post-treatment stage. The data collected were analyzed using descriptive and inferential statistics. The research question was answered using mean, standard deviation while t-test and analysis of covariance (ANCOVA) were used to test the hypotheses and Sheffe post-hoc analysis was used. Hypotheses were tested using t-test at 0.05 level of significance.

Table 1: Mean and standard deviation of pre-test and post-test scores of students in experimental and control groups.

Strategies	Test	N	Mean	S.D	Mean Diff.
Classroom Verbal Interaction	Pre-test	98	44.29	2.47	40.06
	Post-test		84.35	5.29	
Conventional method	Pre-test	59	44.30	2.47	3.90
	Post-test		48.20	2.04	
Total		157			

Table 1 revealed that pre-test performance mean scores of students exposed to Classroom Verbal Interaction was 44.29 while conventional method was 44.30 with their corresponding standard deviations as 2.47 and 2.47 respectively in Physics. The post-test performance mean scores of students exposed to Classroom Verbal Interaction was 84.35 and conventional method was 48.20 with their corresponding standard deviations as 5.29 and 2.04 respectively in Physics. The mean difference in Classroom Verbal Interaction was found to be 40.06 while that of the conventional method group was found to be 3.90. This implied that the use of Classroom Verbal Interaction had significant influence on the academic performance of students in Physics.

Hypothesis 1: There is no significant difference in the pre-test performance mean scores of students exposed to Classroom Verbal Interaction (CVI) and conventional method.

Students' pre-treatment performance was analysed using t-test at the 0.05 level of significance to test the hypothesis. Table 2 displays the final result.

Table 2: t-test analysis for pre-test performance mean scores of students exposed to online learning strategy and conventional method.

Variations	N	Mean	SD	df	t-value
Classroom Verbal Interaction	98	44.29	2.43	155	.982
Conventional method	59	44.30	2.47		

P>0.05

Table 2 showed that the t-value is not significant because the P value (0.982) > 0.05 at 0.05 level of significance. Therefore, the null hypothesis is not rejected. Hence, there is no significant difference in the pre-test performance mean scores of students exposed to Classroom Verbal Interaction (CVI) and conventional methods. By implication, the students in the experimental and control groups were homogeneous at the commencement of the study.

Hypothesis 2: Classroom Verbal Interaction (CVI) and conventional method are not significantly different in their effectiveness on the academic performance of Secondary School Students in Physics.

Students' post-test mean scores were analyzed using t-test at the 0.05 level of significance to test the hypothesis. Table 3 displays the final result.

Table 3: t-test analysis for post-test performance mean scores of students exposed to Classroom Verbal Interaction and conventional method.

Variations	N	Mean	SD	df	t-value
Classroom Verbal Interaction	98	84.35	5.29	155	.000
Conventional method	59	48.20	2.04		

*P<0.05

Table 3 revealed that the t-value is significant because the P value (0.000) < 0.05 at 0.05 level of significance. Therefore, the null hypothesis was rejected. Classroom Verbal Interaction (CVI) and conventional method were significantly different in their effectiveness on the academic performance of Secondary School Students in Physics. Students in the Classroom Verbal Interaction performed better than their counterparts in the control group

Discussion

The finding of this study revealed that the performance of students in both experimental and control groups in pre-test were low and do not differ statistically. This finding established the homogeneity of the two groups involved in the study prior to the treatment. In other words, it could be said that the knowledge baseline for the two groups involved in the study are equal.

A comparison of post-test performance mean scores of students who were taught using the Classroom Verbal Interaction and the Conventional Method showed a statistically significant difference. High grades in Physics were earned by those students who were exposed to the Classroom Verbal Interaction. This is consistent with the claim of Bolarinwa and Okolocha (2016) that students' performance is more influenced by classroom interaction than the teachers' act. This result is possible as the interaction that took place in the classroom during instruction could enhance the effectiveness of the lesson and by implication, students' academic performance. The learning process and curiosity of the students were aroused as they were given the opportunities to relate with themselves, their teachers and have the ample means of surfing

for more knowledge based on the tasks given them by the teachers.

Conclusion

Based on the findings of this study, it could be concluded that, Classroom Verbal Interaction is a virile instruction strategy for improving the students' academic performance in Physics.

Recommendations

1. Teachers of Physics should deploy Classroom Verbal Interaction by developing activities that will give room for learners to be active participants in the teaching and learning process
2. Government should organise seminars and orientations for the teachers on the use of Classroom Verbal Interaction in Physics class in secondary schools so as to enhance better academic performance of students.
3. The curriculum planners should improve on the Physics curriculum

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EMOTIONAL INTELLIGENCE, PERSONAL COMPETENCE, SELF-REGULATION AND DECISION MAKING AS PREDICTORS OF UNDERGRADUATE STUDENTS' LEARNABILITY IN BIOLOGY

BY

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Abstract

The research investigated the role of emotional intelligence, personal competence, self-regulation, and decision-making as predictors of undergraduate students' learnability in Biology. A descriptive survey research design was employed for this study. The sample comprised three hundred and twenty (320) third-year students from the Department of Biological Sciences, Tai Solarin Federal University of Education, selected through the intact class sampling method. Data were collected using an adapted questionnaire. The analysis of the data was conducted using descriptive statistics, Pearson's Product-Moment Correlation (PPMC), and multiple regression. Findings revealed that the levels of biology undergraduate students' emotional intelligence, personal competence and self-regulation were high, while the students' level of decision making was low. There was significant relationship between biology undergraduate students' academic performance and personal competence. Meanwhile, there

were no significant relationships between students' academic performance and the students' emotional intelligence, self-regulation and decision-making. However, there existed significant correlations among the students' emotional intelligence, personal competence, self-regulation, and decision-making. The personal competence of undergraduate biology students significantly influenced their academic performance. The findings suggest that university administrators should facilitate workshops aimed at enhancing students' decision-making competencies, thereby fostering the development of more robust critical thinking and problem-solving skills.

Keywords: Emotional intelligence, Personal competence, Self-regulation, Decision making.

Introduction

The concept of learner characteristics is fundamental within the fields of learning science and cognition, serving to identify the specific demographic of students and to assess various dimensions of their personal, academic, social, or cognitive profiles that may impact their learning processes. Understanding learner characteristics is crucial for instructional designers, as it allows for the development of tailored educational experiences that cater to the needs of the target audience. One significant aspect of the learning process is literacy ability, which plays a vital role in enabling learners to effectively and accurately assimilate information. Learner characteristics can be categorized into individual mental factors that influence educational activities, encompassing personal, academic, social/emotional, and cognitive dimensions (Nakayama *et al.*, 2021).Hence, it is imperative to study emotional intelligence, personal competence, self-regulation, and decision-making of students. These characteristics are interrelated and often influence each other. For instance, high emotional intelligence can enhance decision-making skills by allowing learners to better understand and manage their emotions when faced with choices. Personal competence can improve self-regulation by fostering a deep understanding of one's abilities and limitations, leading to more effective management of learning behaviours. Together, these characteristics create a foundation for a learner's overall academic success and personal development. Incorporating these characteristics into educational programmes and encouraging their development in learners can lead to more effective and holistic learning experiences, which has influence on academic performance (Nakayama *et al.*, 2021).

Emotional intelligence (EI) encompasses the capacity to identify, comprehend, and regulate one's own emotions, in addition to the ability to recognize, interpret, and impact the emotions of others. Intelligence is one of the attributes that educators should be aware of in order to support kids who are struggling academically and raise student achievement. High performers have both of these qualities. Cognitive and emotional intelligence capabilities complement each other. Uncontrolled emotions might make a person more prone to ignorance. Without emotional intelligence, people won't be able to fully utilize their cognitive ability (Arghode *et al.*, 2022).

Decision-making constitutes the process of selecting among alternatives by recognizing a decision, collecting relevant information, and evaluating potential solutions. Proficient decision-making abilities are essential for students as they progress through their educational experiences. Effective decision-making encompasses critical thinking, problem-solving, and the careful consideration of the advantages and disadvantages associated with different options. Learners who can make sound decisions are often

more confident and proactive in their studies, leading to better academic outcomes. They can prioritize tasks, manage their time efficiently, and make choices that align with their long-term educational and career goals (Vany *et al.*, 2023). The decision-making styles of students represent a variable factor that differs among individuals, potentially contributing to procrastination in academic tasks related to assignment workloads. Decision-making style can be characterized as a learned habitual response pattern that individuals exhibit when faced with decision-making scenarios. It is important to note that this style is not a personality trait; rather, it reflects a habitual inclination to respond in a particular manner within specific decision-making contexts (Majeed, 2021).

Furthermore, personal competence encompasses students' collaborative learning behaviors and communication skills, which enable them to effectively express, communicate, assist, share, and offer compliments to their peers within educational environments. This concept of personal competence includes elements of self-awareness and self-management. Self-awareness pertains to the recognition of one's emotions, strengths, weaknesses, values, and motivations, while self-management involves the regulation of one's emotions and behaviors across various situations (Omidullah & Javed, 2020). For learners, personal competence is essential as it impacts how they perceive and react to challenges. High personal competence allows learners to set realistic goals, stay focused, and persist through difficulties. It also involves self-motivation and a commitment to continuous self-improvement, both of which are critical for academic success (Nwigwe *et al.*, 2024). The students' personal competence plays a significant role in their academic performance, which may not be fully assessed through cognitive evaluations. Furthermore, students' collaborative learning behaviors exhibit both direct and indirect relationships with their present and future academic outcomes. Those students who demonstrate effective engagement and possess personal competencies are likely to achieve favorable academic results (Nisar *et al.*, 2022).

Self-regulation is defined as the capacity to effectively govern one's cognitive processes, emotional responses, and behavioral actions in pursuit of long-term objectives; it involves self-discipline, self-control, and the ability to delay gratification (Sahranavard *et al.*, 2018). Learners who excel in self-regulation can stay on task, avoid distractions, and maintain a steady pace of work; this characteristic is particularly important in the context of independent learning and time management. Self-regulated learners can monitor their progress, adjust their strategies as needed, and remain motivated even in the face of setbacks. They tend to perform better academically because they can effectively manage their learning processes (Ononuju *et al.*, 2023). Self-regulation among students is a critical component in evaluating academic success. It is intricately linked to study skills, which encompass a student's capacity to take responsibility for and manage their own learning processes. Furthermore, self-regulation involves the establishment of learning objectives, the formulation of strategies to achieve these objectives, and the on-going assessment of progress towards their realization. The acceptance of responsibility is a fundamental aspect of self-regulation that students are expected to uphold (Zawadi, 2024). Stewart and Maisonville (2020) assert that the principle of academic integrity necessitates that each student assumes responsibility for their own work, thereby ensuring that all students have equitable access to a quality education, free from unlawful disruptions caused by the actions of others.

Statement of the Problem

The problem of low academic performance in biology among students represents a significant challenge for both educators and learners. This phenomenon can be attributed

to a multitude of factors, including influences from the individual student, parental involvement, institutional support, societal context, and governmental policies. Low academic performance is characterized by students achieving grades that fall below the normative average for a given subject area. This underperformance may be attributed to a range of factors, particularly those related to the personal characteristics of the students, including emotional intelligence, individual competence, self-regulation, and decision-making skills. The primary issues contributing to students' low academic performance may be linked to insufficient learner characteristics, particularly a deficiency in emotional intelligence. This inadequacy can impede their capacity to effectively manage stress and emotions, ultimately resulting in diminished focus and motivation. Furthermore, a lack of personal competence may lead to inadequate self-awareness and self-management skills, which can hinder students' ability to establish and accomplish their academic goals. Furthermore, inadequate self-regulation skills can lead to difficulties in maintaining attention, avoiding distractions, and managing time effectively. Finally, poor decision-making skills may result in students being unable to prioritize tasks, choose effective study strategies, or make beneficial academic choices. Collectively, these deficiencies in learner characteristics can create a significant barrier to academic success, particularly in demanding subjects like biology. It is therefore imperative to examine emotional intelligence, personal competence, self-regulation and decision making as predictors of academic performance undergraduate biology students.

Aim and Objectives of the Study

This study aimed to examine emotional intelligence, personal competence, self-regulation and decision making as predictors of undergraduate biology students' academic performance. Specifically, the study aimed to:

i. determine the levels of undergraduate biology students' emotional intelligence, personal competence, self-regulation and decision making.
ii. find out the levels of undergraduate biology students' emotional intelligence, personal competence, self-regulation and decision making based on gender, and age of students.
iii. examine the relationship that exist among undergraduate biology students' emotional intelligence, personal competence, self-regulation, decision making and their learnability.
iv. investigate the individual and combined impacts of undergraduate biology students' emotional intelligence, personal competence, self-regulation and decision making on students' learnability.
v. explore the combined effect of emotional intelligence, personal competence, self-regulation, decision making of undergraduate students on their learnability in Biology.

Methodology

Research Design: The study was conducted utilizing a descriptive survey research design.

Population of the Study: The study's target population consisted of undergraduate students enrolled in the Department of Biological Sciences at Tai Solarin Federal University of Education, Ijagun, Ogun State.

Sample and Sampling Technique: The study's sample comprised three hundred and twenty (320) third-year students enrolled in the Department of Biological Sciences at Tai Solarin Federal University of Education. Intact class that cohort the entire 300-level students were used for the study. This method was chosen for practicality and efficiency, as it enabled the researcher to gather data from a pre-existing group of students without the need for random sampling. The intact class technique is often employed in educational research when the population is easily

accessible and when seeking to ensure that the study represents a typical sample of students.

Research Instrument: The instrument used for collecting data was through administration of close ended questionnaire, which comprised four (4) scales: Emotional Intelligence Scale, Personal Competence Scale, Self-Regulation Scale, and Decision-Making Scale. The academic performance data for this study was obtained from students' examination scores of BIO 321 (General Physiology) in the 2023/2024 academic session.

Method of Data Analysis: In the context of data analysis, descriptive statistics—comprising frequencies, percentages, means, and standard deviations—were employed to assess the demographic characteristics of the participants. To investigate the relationships among emotional intelligence, personal competence, self-regulation, decision-making, and academic performance, inferential statistics, specifically Pearson's correlation and linear regression, were utilized. The analysis was conducted using Statistical Package for Social Sciences (SPSS) version 20.

Results: Presented in Table 1 are the levels of undergraduate biology students' emotional intelligence, personal competence, self-regulation and decision making. This study found the emotional intelligence of the students to have minimum and maximum levels of 60 and 115, respectively, of which the calculated mid-point was found to be 87.5. The mean emotional intelligence of the students was 94.48 ± 9.32, which was found to be higher than the mid-point, therefore, the students' emotional intelligence is said to be high. Also, the students' level of personal confidence had minimum and maximum values of 44 and 75, respectively, of which the calculated mid-point was found to be 59.5. The mean personal competence of the students was 62.70 ± 6.46, which was discovered to be higher than the mid-point, therefore, the students level of personal competence is said to be high. Similarly, the students' level of self-regulation was found to have minimum and maximum values of 44 and 75, respectively, of which the calculated mid-point was 59.9. The mean self-regulation of the students was 62.14 ± 6.25, which was found to be higher than the mid-point. Therefore, this study found the level of students' self-regulation to be high. However, the level of students' decision-making had minimum and maximum values of 44 and 92, respectively. The mean decision-making of the students was 60.64 ± 6.89, which was found to be lower than the mid-point. Therefore, this study found the level of students' decision making to be low.

Table 1: Levels of undergraduate biology students' emotional intelligence, personal competence, self-regulation and decision making.

	Minimum	Maximum	Mid-point	Mean	Std. Dev.	Remark
Emotional Intelligence	60	115	87.5	94.48	9.32	High
Personal Competence	44	75	59.5	62.70	6.46	High
Self-regulation	44	75	59.5	62.14	6.25	High
Decision Making	44	92	68	60.64	6.89	Low

Table 2 shows the levels of undergraduate biology students' emotional intelligence, personal competence, self-regulation and decision making based on the gender of the students. The study indicated that there was no statistically significant difference in emotional intelligence between male and female students (p = 0.470), whereas, female students emotional intelligence (94.70 ± 9.01) was found to be higher than that of the male students (93.82 ± 10.23). Also, there was no statistically significant difference between male and female students' personal competence (p = 0.805). However, the female students were found to have a relatively higher personal competence (62.75 ± 6.39) than their male counterparts (62.54 ± 6.69). Furthermore, the students' self-regulation was found not to be statistically significant in terms of their gender (p = 0.681). Meanwhile, the female students were found to have a higher self-regulation (62.22 ± 6.22) than the male students (61.89 ± 6.36). However, the students' level of decision making was found to be relatively higher among the female students (60.68 ± 6.66) than the male students (60.51 ± 7.61). Meanwhile, the difference in the decision making of the students was not statistically significant (p = 0.842).

Table 2: Levels of undergraduate students' emotional intelligence, personal competence, self-regulation and decision making based on their gender

	Gender	Mean	Std. Deviation	Sig.
Emotional Intelligence	Male	93.82	10.23	0.470
	Female	94.70	9.01	
Personal Competence	Male	62.54	6.69	0.805
	Female	62.75	6.39	
Self Regulation	Male	61.89	6.36	0.681
	Female	62.22	6.22	
Decision Making	Male	60.51	7.61	0.842
	Female	60.68	6.66	

Table 3 displays the levels of emotional intelligence, personal competence, self-regulation, and decision-making among students, categorized by age. The findings indicate that the youngest students exhibited elevated levels across all positive variables, whereas those within the 16-20 age group demonstrated the lowest values for these variables. This observation suggests that commencing college at a younger age may foster more favorable attitudes in students.

Table 3: Levels of undergraduate students' emotional intelligence, personal competence, self-regulation and decision making based on their age categories.

	Age	Mean	Std. Deviation	Sig.
Emotional Intelligence	15 years and below	107.00	0.00	0.243
	16-20 years	93.74	9.28	
	21 years and above	94.84	9.32	
Personal Competence	15 years and below	65.00	0.00	0.293

	16-20 years	61.96	6.45	
	21 years and above	63.11	6.45	
Self-Regulation	15 years and below	70.00	0.00	0.376
	16-20 years	61.83	6.63	
	21 years and above	62.27	6.02	
Decision Making	15 years and below	62.00	0.00	0.496
	16-20 years	60.03	6.58	
	21 years and above	60.98	7.07	

Table 4 shows the relationships that occur among students' emotional intelligence, personal competence, self-regulation and academic performance. The findings of this study indicate a statistically significant and positive correlation between students' academic performance and their personal competence, with a correlation coefficient of r = 0.189 and a p-value of 0.001. However, this study found low and no significant relationship (p > 0.05) between students' academic performance and students' emotional intelligence (r = 0.079); students' self-regulation (r = 0.072) and students' decision making (r = 0.024). However, this study found high, positive and significant relationships between students' emotional intelligence and students' personal competence (r = 0.605; p = 0.000); students' self-regulation (r = 0.579; p = 0.000) and students' decision making (r = 0.545; p = 0.000). Furthermore, this study found high, positive and significant relationships between students' personal competence and students' self-regulation (r = 0.659; p = 0.000) and students' decision making (r = 0.552; p = 0.000). Also, this study discovered a high, positive and significant relationship between students' self-regulation and students' decision making (r = 0.640; p = 0.000).

Table 4: Correlations among emotional intelligence, personal competence, self-regulation, decision making and learnability of undergraduate biology students.

	Emotional Intelligence	Personal Competence	Self Regulation	Decision Making	Students' Learnability
Emotional Intelligence					
Personal Competence	0.605**				
Self-Regulation	0.579**	0.659**			
Decision Making	0.545**	0.552**	0.640**		
Students' Learnability	0.079	0.189**	0.072	0.024	

Table 5 shows the interactive effects of undergraduate biology students' emotional intelligence, personal competence, self-regulation and decision making on their academic performance. The regression model shows R^2 value as 0.046; indicating that

students' emotional intelligence, personal competence, self-regulation and decision making jointly accounted for 4.6% of the variance in the academic performance of the students. However, the model was found to be statistically significant ($F_{4, 315} = 3.382$; Sig. = 0.005; $R^2 = 0.046$).

Table 5: Combined effects of emotional intelligence, personal competence, self-regulation and decision making of undergraduate biology students on their learnability.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	$R^2 = 0.046$; $F_{4, 315} = 3.382$; p = 0.005				
	B	Std. Error	Beta		
Emotional Intelligence	-0.018	0.109	-0.012	-0.164	0.870
Personal Competence	0.589	0.168	0.278	3.507	0.001
Self-Regulation	-0.096	0.182	-0.044	-0.528	0.598
Decision Making	-0.189	0.149	-0.095	-1.264	0.207

Discussion of Findings

The study found that the levels of emotional intelligence, personal competence, and self-regulation among biology undergraduates were high, but decision-making was low. This result is in consonance with findings from Nieto-Carracedo *et al.* (2024), who emphasized the role of emotional intelligence in influencing academic outcomes indirectly through mediating factors like emotional well-being and motivation. Similarly, Kwaku *et al.* (2024) stated that while emotional intelligence may correlate with academic performance, its influence is not direct for all components, particularly self-awareness and self-management. Thus, the high levels of emotional intelligence and self-regulation among students, coupled with the non-significant direct impact on academic performance, reflect broader findings suggesting that emotional intelligence operates through complex mediation pathways.

The study showed that there were no statistically significant differences in the male and female undergraduate students' levels of emotional intelligence, personal competence, self-regulation as well as decision making. The finding contrasts with the study of Nabina and Ashish (2024), where no significant difference was found in emotional intelligence across demographic variables like ethnicity and parental education, though their study did note age as a factor. This divergence from some earlier studies suggests that the relationship between demographic factors and emotional intelligence or decision-making may vary based on cultural or institutional contexts.

The study indicated that there were no statistically significant differences in the levels of emotional intelligence, personal competence, self-regulation, and decision-making among biology undergraduate students

when analyzed according to their age categories. This outcome is consistent with the findings of Zawadi (2024) and Omidullah and Javed (2020), who underscore the significance of self-competence and self-regulation in relation to academic success. Zawadi specifically noted that students' self-regulatory strategies play a vital role in academic achievement, especially within open and distance learning contexts. This is reflected in the significant impact of personal competence on the students' performance in the present study, suggesting that personal skills like self-confidence and goal-setting are pivotal in academic contexts. However, the non-significant relationship between emotional intelligence and academic performance found in this study mirrors the results of Bilimale *et al.* (2024), where emotional intelligence did not correlate positively with academic outcomes, supporting the view that academic performance is influenced more by cognitive rather than emotional skills.

The study also indicated that there was significant relationship between biology undergraduate students' academic performance and personal competence. Meanwhile, there were no significant relationships between students' academic performance and students' emotional intelligence, students' self-regulation and students' decision making. However, there existed significant correlations among students' emotional intelligence, personal competence, self-regulation as well as students' decision making. Although decision-making was found to have no significant impact on academic performance, this finding contrasts with studies like Vany *et al.* (2023), which reported that avoidant decision-making styles predict academic procrastination, thus influencing academic performance. The lack of impact in the current study may suggest that while decision-making influences behaviors like procrastination, it might not directly affect overall academic performance, or that the students in the present study may not rely heavily on decision-making processes in ways that significantly impact their grades.

The study showed that Biology undergraduate students' personal competence had significant impact on the learnability of the students. However, this study found no significant impact of undergraduate biology students' emotional intelligence, self-regulation and decision making on undergraduate students' academic performance. Meanwhile, the regression model of the variables was found to be significant. This finding indicates that these factors are interdependent, aligning with the views of Khan *et al.* (2023), who noted that emotional intelligence is positively associated with the ability to adapt to different situations, a key aspect of self-regulation. Furthermore, Kongqi *et al.* (2024) demonstrated that self-regulation mediates the relationship between resilience and academic performance, highlighting the interplay of emotional intelligence and self-regulation in academic contexts. The regression model in the current study, which demonstrated the significance of these factors collectively, reinforces the importance of considering emotional, personal, and cognitive skills as interconnected influences on student performance.

Conclusion

Conclusively, the high levels of emotional intelligence, personal competence, and self-regulation among Biology undergraduate students reflect their strong abilities in managing emotions, demonstrating interpersonal skills, and regulating their behavior. However, the low level of decision-making indicates a potential area for improvement in critical thinking and problem-solving. The lack of statistically significant differences based on gender and age across emotional intelligence, personal competence, self-regulation, and decision-making suggests that these factors are consistent across demographic groups. The significant relationship between academic performance and personal competence highlights the importance of interpersonal skills in academic success. On the other hand, the absence of significant relationships between emotional intelligence, self-regulation, decision-making,

and academic performance indicates that these factors may not directly influence students' grades. The notable relationships observed among emotional intelligence, personal competence, self-regulation, and decision-making suggest a degree of interrelatedness that may have an indirect impact on academic performance.

Recommendations

In light of the findings, the subsequent recommendations have been proposed:

- University administrators should organize workshops to improve students' decision-making skills, helping them develop stronger critical thinking and problem-solving abilities.
- Educators should incorporate personal competence development into the curriculum, emphasizing interpersonal skills to enhance students' academic performance.
- Biology departments should provide tailor mentorship programmes toward addressing students' emotional intelligence, supporting them in managing academic stress and improving overall well-being.
- Researchers and education policymakers should investigate more on effective interventions aimed at enhancing students' decision-making skills, thereby promoting comprehensive development that contributes to academic achievement.

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THE ECON-PSYCH NEXUS: AN EDUCATIONAL PSYCHOLOGY PERSPECTIVE ON CULTIVATING AN ECONOMIC MINDSET FOR LEARNING

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Abstract

This conceptual study proposes the Econ-Psych Nexus as an integrative framework to address the persistent deficit in economic literacy, which originates from a fundamental misalignment between traditional instructional methods and the science of learning. Synthesizing literature from educational psychology and economic education, the paper argues that cultivating a robust economic mindset characterized by scarcity-awareness, incentive-analysis, systems-thinking, and marginal reasoning requires addressing specific psychological barriers, namely naïve theories (folk economics), cognitive biases, and motivational-affective factors. The analysis demonstrates how these barriers actively hinder the acquisition of transferable economic reasoning and culminates in a structured pedagogical approach grounded in the principles of conceptual change, metacognitive development, and motivated learning to bridge the gap between inert knowledge and genuine, applicable economic thought. The study concludes by recommending a foundational shift toward psychologically-informed economic education, entailing a transformation in curriculum design, assessment, and teacher training, and outlines a robust agenda for future empirical research to validate the proposed framework.

Keywords: Economic Education, Economic Mindset, Conceptual Change, Metacognition, Educational Psychology

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Introduction

The Critical Need for an Econ-Psych Nexus

Economic education faces a persistent paradox, despite its central role in preparing citizens for informed personal and civic decision-making, its effectiveness remains alarmingly inconsistent. National assessments reveal enduring deficits in economic understanding among both high school graduates and adults (Walstad & Rebeck, 2017), suggesting that traditional instructional models, often reliant on graphical analysis and lecture-

based transmission of models, fail to foster durable, flexible reasoning. This failure is not a reflection of student capability but rather of pedagogy; the field has prioritized content delivery over the cognitive architecture of the learner (Bransford, Brown, & Cocking, 2000).

This paper contends that resolving this paradox requires a deliberate synthesis of economic content knowledge with the science of learning from educational psychology. We label this integration the Econ-Psych Nexus. Our central thesis is that cultivating an economic mindset is fundamentally a psychological endeavor. It is less about transmitting information and more about managing the complex process of conceptual change, mitigating innate cognitive biases, and building robust motivation. An economic mindset is often counter-intuitive, clashing with deeply held naïve theories and heuristic thinking. Therefore, effective instruction must be designed to trigger cognitive conflict, make the processes of thought visible, and demonstrate the profound utility of economic reasoning.

The purpose of this conceptual analysis is to construct a bridge between these disciplines. We will deconstruct the economic mindset, identify the specific cognitive and motivational barriers that impede its development, and propose a framework of pedagogical principles grounded in empirical evidence from the learning sciences. This paper is a call for economic educationists to embrace the tools of educational psychology and for educational psychologists to recognize economic reasoning as a critical domain for applying theories of conceptual change and motivation. By exploring the Econ-Psych Nexus, we can move beyond teaching economics as a subject toward cultivating economists as thinkers.

Conceptual Foundation: Deconstructing the Economic Mindset

An economic mindset transcends the recall of facts about markets or indicators; it is a cultivated disposition, a habit of mind that involves perceiving the world through a specific conceptual lens. This lens is defined by several interrelated components that enable sophisticated economic reasoning (Siegfried & Meszaros, 1997).

The foundational component is scarcity-awareness. This is the understanding that all resources whether temporal, financial, or material are finite. This inescapable reality implies that every choice entails a trade-off, giving rise to the critical concept of opportunity cost. The economic thinker instinctively operationalizes this concept, consistently asking, "What is the next best alternative that must be forgone?"

Closely linked is the practice of incentive-analysis. An economic mindset involves a default orientation toward identifying the structure of costs and benefits that predictably guide human behavior. It is an understanding that policies, institutions, and social interactions create incentive structures that shape choices, moving explanation from a focus on individual character to an analysis of systemic design (Heyne, 2000).

Furthermore, economic reasoning requires systems-thinking. Events are rarely isolated; they are emergent outcomes of dynamic, complex systems. A price change, a shift in unemployment, or a new regulation creates ripple effects and feedback loops, often leading to unintended consequences. The economic thinker strives to identify these connections and anticipate secondary effects, avoiding

simplistic, one-cause, one-effect explanations.

A sophisticated economic mindset employs marginal analysis. This is the habit of thinking incrementally, evaluating the additional benefits against the additional costs of a small change in activity. It is the difference between asking "Should I go to university?" (An all-or-nothing question) and "Should I complete a fourth year of university?" (A marginal question). This nuanced approach is the cornerstone of optimized decision-making.

The ultimate objective of developing this mindset is transfer the ability to apply these habits of mind flexibly and effectively to novel, real-world contexts, from designing a personal budget to evaluating the long-term impact of a trade policy (Barnett & Ceci, 2002). Achieving this level of conceptual understanding requires overcoming significant and predictable psychological barriers.

Thematic Analysis: Psychological Barriers to Economic Reasoning

The development of an economic mindset is not a process of passive reception but an active and often resistant cognitive restructuring. Learners enter the classroom with a pre-existing set of intuitive beliefs, mental shortcuts, and motivational frameworks that can systematically hinder the adoption of formal economic reasoning.

A primary barrier is the presence of naïve theories, also known as folk economics or preconceptions (Vosniadou, 2013). Students are not blank slates; they have constructed intuitive models to explain economic phenomena based on anecdotal experience and cultural narratives (Leiser & Halachmi, 2006). For instance, many hold a naïve theory of cost-based price determination or view profit as inherently exploitative (Furnham, 1996). These theories are robust and resistant to change. Educational psychology demonstrates that simply presenting the correct economic model is often ineffective, as students frequently assimilate new information into their old framework, distorting its meaning to avoid cognitive dissonance (Posner, Strike, Hewson, & Gertzog, 1982). Meaningful learning requires conceptual change a difficult process that involves making students aware of their pre-existing models, creating deliberate cognitive conflict by revealing the models' inadequacies, and then demonstrating the greater plausibility, fruitfulness, and intelligibility of the scientific economic model.

Equally formidable are the universal cognitive biases that systematically distort human judgment. Economics is the study of rational choice, yet the human brain is wired with heuristics that frequently lead to sub-optimal outcomes (Kahneman, 2011). The sunk cost fallacy compels us to escalate commitment to a failing course of action due to a aversion to loss. Confirmation bias leads us to seek information that confirms our pre-existing beliefs about markets or government intervention. The affect heuristic causes us to make judgments based on emotional reactions rather than objective analysis. These biases are not merely topics within behavioral economics; they are active impediments to learning economics itself. A student prone to the sunk cost fallacy will struggle to internalize the concept of opportunity cost, which requires ignoring past, irretrievable investments. Therefore, economic education must be explicitly metacognitive (Flavell, 1979). It must teach students about these

biases, provide them with the language to label them, and train them to monitor and regulate their own thinking, effectively using economic principles as tools for debiasing and improving judgment (Larrick, 2004).

Beyond cognitive barriers, motivational and affective factors play a decisive role. A student's willingness to engage in the demanding work of conceptual change and metacognitive monitoring depends heavily on their motivation. According to Expectancy-Value Theory (Eccles & Wigfield, 2002), motivation is determined by a student's belief in their ability to succeed (self-efficacy) and their perception of the task's value (attainment, intrinsic, or utility value). Economics is often perceived as abstract, mathematically daunting, and irrelevant to daily life, which undermines both efficacy and value. This can trigger economics anxiety (Erickson & Erickson, 2020), a phenomenon akin to math anxiety (Ashcraft, 2002), where negative emotions consume cognitive resources and further impede performance. Furthermore, social identity and stereotypes can influence engagement; if students do not see people like themselves as "economic thinkers," they may disidentify with the subject, viewing it as incompatible with their identity (Avery & Walker, 2020). Traditional instruction that focuses on abstract models without connecting them to authentic, relatable problems exacerbates these motivational gaps, fostering surface-level learning strategies aimed solely at passing exams.

These cognitive and motivational barriers coalesce to create a significant transfer problem. Students may learn to solve specific, formulaic problems in the classroom (near transfer) but remain unable to apply economic principles to new, complex situations (far transfer) (Perkins & Salomon, 2012). Transfer is the ultimate goal but is notoriously difficult to achieve because it requires a deep, conditional understanding of when and why to apply a concept. Without instruction designed to overcome naıve theories, mitigate biases, and build genuine motivation, knowledge remains inert, context-bound, and ultimately useless beyond the classroom walls.

Proposed Framework: Principles of the Econ-Psych Nexus

To overcome these barriers, economic pedagogy must be fundamentally redesigned around evidence-based principles from educational psychology. The following framework outlines core principles for cultivating an economic mindset.

Fostering Conceptual Change through Cognitive Conflict Instruction must be designed to deliberately surface students 'intuitive theories and create productive moments of cognitive dissonance. The Predict-Observe-Explain cycle is a powerful strategy for this purpose (White & Gunstone, 1992). For example, before teaching supply and demand, pose a scenario: "A major frost destroys half of Brazil's coffee crop. What will happen to the price of coffee at your local store next week? Why?" Students will often predict a slow, cost-driven increase. Showing data or a news article revealing a rapid price spike creates a powerful conflict that makes them dissatisfied with their naive theory and highly receptive to the explanatory power of market equilibrium models. This strategy moves students from a state of passive reception to active cognitive engagement.

Developing Metacognition to Mitigate Bias Economic thinking must be made visible and explicit. This involves directly teaching heuristics and biases by name and integrating constant reflection into the curriculum (Schraw & Moshman, 1995). After a lesson on the sunk cost fallacy, have students journal about a personal experience with it (e.g., finishing a bad movie because they paid for the ticket). In case study analyses, require students to not only apply economic models but also to identify which cognitive biases might be influencing the actors in the scenario. This builds a lifelong habit of "thinking about their own thinking," positioning economics not as an abstract theory but as a practical debiasing tool for improved personal and professional decision-making.

Building Motivation through Authenticity and Scaffolding To combat perceptions of irrelevance and low self-efficacy, learning must be situated in authentic, meaningful contexts (Brown, Collins, & Duguid, 1989). Replace decontextualized problems with project-based learning: task students with designing a business plan for a startup, creating a policy proposal to address a local issue, or negotiating a simulated international trade agreement. These tasks demonstrate tangible utility value. To build efficacy, these complex tasks must be scaffolded broken down into manageable steps with formative feedback provided at each stage (Vygotsky, 1978). This ensures students build confidence and competence simultaneously, reducing anxiety and fostering a growth mindset.

Promoting Transfer through Varied Practice and Abstraction

To encourage far transfer, students must practice applying principles across a wide variety of contexts and must be guided to abstract the underlying principle from its specific instances (Barnett & Ceci, 2002). Teach a concept like incentives, and then have students analyze them in a novel, a historical event, a corporate structure, and their own school environment. After working through multiple examples, facilitate a discussion where students abstract the core principle. Ask, "What is the deep, underlying structure that all these examples share?" This process of contrasting cases helps students form a flexible mental representation of the concept, making it far more likely they will recognize its application in an unfamiliar future situation.

Psychological Principle	Key Barrier Addressed	Instructional Strategy	Example Application
Conceptual Change	Naïve Theories	Predict-Observe-Explain Cycles	Predict price changes after a supply shock; compare to real data to trigger conflict.
Metacognition	Cognitive Biases	Explicit Instruction & Reflection	Journal about personal sunk cost examples; identify biases in case studies.
Motivation (Value)	Perceived Irrelevance	Authentic, Problem-Based Tasks	Design a policy for a local issue; create a business plan.

Motivation (Efficacy)	Anxiety & Low Confidence	Scaffolded Practice with Feedback	Break complex tasks into steps with feedback at each stage.
Transfer of Learning	Inert Knowledge	Varied Practice & Abstraction	Apply a single concept (e.g., incentives) to diverse, novel contexts.

Implications for Theory, Practice, and Future Research

The Econ-Psych Nexus framework carries significant ramifications across educational domains. Theoretically, it provides a coherent model for integrating two previously siloed fields, arguing that economic reasoning is a form of literacy whose acquisition is best understood and facilitated through the lens of the learning sciences. It posits that the failure to achieve transfer is not a failure of student intellect but a predictable outcome of instruction that ignores the natural functioning of the human mind.

For practice, this demands a transformation in curriculum design, assessment, and teacher preparation. Curricula must be sequenced to prioritize the surfacing of intuitive conceptions before formal models are introduced. Assessment must evolve beyond multiple-choice tests of definitions and calculations to include authentic measures of conceptual understanding and transfer, such as performance tasks, reflective journals, and analyses of novel case studies (McGoldrick, 2018). Most critically, teacher education and professional development must be overhauled. Economic educators need to be trained not only as content experts but as learning scientist's professionals adept at diagnosing naive theories, designing for conceptual change, and fostering metacognitive and motivational competencies.

This conceptual analysis naturally leads to a robust agenda for future empirical research. Studies are needed to validate and refine this framework. Key questions include:

- How do specific interventions like Predict-Observe-Explain cycles directly impact conceptual change in economics compared to traditional instruction?
- Does explicit metacognitive training reduce the impact of cognitive biases like the sunk cost fallacy on economic decision-making in real-world contexts?
- To what extent do authentic, project-based assessments correlate with improvements in far transfer and long-term retention of economic concepts?
- How can teacher professional development programs most effectively integrate these psychological principles to change instructional practices?

Research should employ mixed-methods designs, combining quantitative measures of learning gains with qualitative analyses (e.g., think-aloud protocols, interviews) to understand how student thinking evolves throughout a course informed by the Nexus principles.

Conclusion

Cultivating an economic mindset is among the most valuable goals of modern education, equipping individuals to navigate personal, financial, and civic challenges with clarity and rationality. However, this goal has remained

persistently elusive under traditional pedagogical models. This paper has argued that achieving it requires a foundational shift: a move from teaching economics as a body of knowledge to teaching for economic thinking as a cognitive and metacognitive skill. The Econ-Psych Nexus provides a roadmap for this shift, synthesizing the science of how people learn with the art of economic education. By designing instruction that deliberately manages conceptual change, embeds metacognitive reflection, and builds motivated engagement through authentic tasks, we can finally bridge the gap between the classroom and the real world. The task ahead is for researchers and practitioners to embrace this interdisciplinary approach, transforming economic education into a powerful, psychologically-informed endeavor for fostering the flexible, critical, and empowered thinkers that our complex world requires.

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EFFECTS OF LABORATORY-BASED INSTRUCTIONAL STRATEGY ON SECONDARY SCHOOL STUDENTS' ATTITUDE TOWARDS CHEMISTRY IN EKITI STATE.

BY

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Abstract
The study investigated the effects of Laboratory-Based Instructional Strategy on the students' attitude towards Chemistry and the impact of gender differences on student's achievement in Chemistry. One research question and one research hypothesis were formulated. The research design adopted in this study was pre-test post-test control group quasi experimental design. The senior secondary one (SSS1) Chemistry students were used. The research design adopted in this study was pre-test post-test control group quasi experimental design. The data collected were analyzed using descriptive and inferential statistics. The research question was answered using means and standard deviation. The hypotheses generated was tested using Analysis of Covariance (ANCOVA) and Univariate Analysis of Variance (two-way ANOVA) at 0.05 level of significance. The data collected was compared in respect of location and gender. The data collected for this study were analyzed using descriptive and inferential statistics. The findings revealed that there was a better improvement in the attitude of students towards Chemistry resulting from their exposure to laboratory-Based Instructional Strategy. The study revealed that Laboratory Based Instructional Strategy is not gender biased.

Keywords: Student's Attitude, exposure, location, Instructional Strategy

Introduction
Science is a field of human endeavor which seeks to explain accurately the events and circumstances that exists within our natural environment. Scientific and technological skill acquisitions are vital tools in coping with the present day challenges. Science is man's way of discovering and investigating about his natural habitation and the entire universe. Science is an activity based subject that is concerned with understanding the working of our world. Science comprises of different subjects out of which Chemistry is one. Chemistry help us to discover more about the behaviour of different kinds of matter. It gives us the reasons for this behaviour and obtains a deep understanding of nature. . Chemistry is fundamental to the world of industrialization.

According to John and Moore (2011), Chemistry is the study of the composition and properties of matter and the changes it undergoes, including energy changes. Chemistry is a practical oriented science subjects that requires a lot of laboratory activities through the incorporation of laboratory-Based Teaching Strategy. John (2016), stated that the term laboratory practical activities means experiences in school settings where students interact with materials to observe and understand the natural world. According to Joshua

(2014), effective laboratory activities that are carefully planned will enhance students' experience, motivation, understanding skills and enjoyment of Chemistry. For effective implementation of chemistry curriculum, teacher should base his teaching on regular laboratory practical work through the adoption of laboratory-based instructional strategy since chemistry is a practical - oriented subject. This could reduce the abstractive nature of chemistry and thereby enhancing better comprehension of the chemical concepts being taught.

Laboratory-based instructional strategy improves students' understanding and retention of information. According to Ojediran, Oludipe & Ehindero (2014), Chemistry is a subject that allow for involvement of students practically for adequate comprehension of the topic taught by the teacher. Therefore, theoretical explanation needs to be supported with actual practices either in the laboratory or outside the laboratory. Doing this will help to simplify learning by making the teaching–learning process effective and understandable to the learners.

It was noted that the low academic achievement of secondary school students in Chemistry was attributed the nonuse of laboratory-Based Teaching Strategy but rather regular use of traditional teaching method. In this case, laboratory work has a central role to play in any such vision of chemistry education. The achievement of students has been a source of concern; our students are not achieving as well as are expected of them and their attitude towards learning of Chemistry is not impressive as expected of them. The result of the study revealed that the school environment of most secondary schools in South West Nigeria are not supportive when it comes to the teaching of science in which chemistry is not an exception. The issue of separate laboratory for science subject is very scarce in the school.

It was observed that many teachers give notes to students in chemistry without better explanation and demonstration through experiment, and this has negative effects on students attitude and' academic performance in chemistry. There are some challenges that is affecting teaching learning process of the learner. Those problems are connected with the teaching methods employed by the teachers, as most of them are not teachers but only accept teaching as the last resort (Terngu. (2010). It was observed that, some students cannot identify many of the apparatus not to talk of how to use them, this was as a result of the lack of exposure to laboratory equipment and laboratory practical activities.

The inadequacies in students' practical competence in Chemistry indicated that there is much to be done in the teaching and learning activities going on in the Chemistry class. The study revealed that adequate teaching and learning of laboratory activities are not taking place in the Chemistry class because majority of Chemistry teacher still use traditional teaching method more than laboratory method of teaching which does not allow students to be actively involved in, and interact with peers.

All the above mentioned reasons will surely result to poor learning outcomes and negative attitude of students towards Chemistry.

Laboratory-Base Instructional Strategy

Laboratory—Base Instructional Strategy is a kind of teaching strategy that involve teaching and learning activities

in which students' working either individually or in small group are involved in manipulating and observing real object and materials. Laboratory activities constitute integral part of Chemistry. Peter and Akeem (2015) opined that Chemistry consists of many topics that can be verified experimentally and which may create an enabling environment for students to learn most of the concepts that are presumed to be abstract. They stressed further that Laboratory method of teaching are of great importance to Chemistry as it increases students interest and performance.

Factors affecting Students Learning Outcome in Chemistry:

Despite the important of chemistry there are some factors that had contributed to the negative attitude of students towards Chemistry and non-acquisition of skills in Chemistry by the secondary school students. Those challenges are mentioned bellow:

- inadequate laboratory facilities,
- inadequate laboratory activities
- teachers' method of teaching (methodology),
- inadequate fund.

Students' Attitude towards Learning of Chemistry

Students' attitude have consequences on how well students learn at their various school. Due to the way the students perceived Chemistry as abstract subject has contributed in no small measure to the students' negative attitude towards Chemistry. Attitude is the inner feeling of an individual towards something or somebody. According to Oxford Advance Learner's Dictionary (2010), attitude is a disposition or state of the mind. Positive attitude in students help to improve performance. The attitude that one has towards an object makes one make judgement as to whether the object is good or bad. Attitudes are linked with academic achievement and that attitudes predict behaviors (Osborne et al. 2010) in Ikechukwu and Akeem (2015)

The attitude of children in their school work is deeply affected by the degree of encouragement their parents give them, and the degree of encouragement given to them by their teacher, and by their own level of emotional stability. There is the tendency for them to exhibit positive or negative encouragement by way of information or demonstration given, or exhibited to them from the onset. It therefore becomes imperative to estimate learners' attitudes towards the instructional medium and instructional approach used for conceptual change to occur. (Jaakkola et al. 2011; Pyatt and Sims 2012).

School Location and the effect on students' academic performance

School location can simply be describes as the settlement or area in which a school is situated. That settlement could either be urban or rural. The school location has an important role to play on the educational achievement or academic performance of the learner in which the schools is located. A school located in rural area will have all the characteristics of rural environment and an urban school will have characteristics of an urban environment based actives that is peculiar to its environment but different from rural location.

Among the factors that affected the effective teaching and learning of chemistry and students' attitude towards Chemistry was attributed to school location. Adu (2016) in his study on

student outcome and school factors as determinant of secondary school effectiveness in Ekiti state Nigeria reported that varies in school tone made negative contribution towards secondary school effectives For example, a school that was located in an isolated area which is also very far away from where people are living is quite different from a schools in time without much stress, many of students are living very far away from their various schools so they treck for hours in the morning before they could reach their schools. Because, many of them are not going by school bus or cars. But Joseph (2015) observed that rural schools tends be smaller than urban schools and that has number benefits since rural student class tend to be smaller, student enjoy more individual attention towards practical work from their teachers and government.

The school location matter most in the student attitude. Oginni and Awobodu (2013) in their study on school location reported that, an enriched environment could result in better performance of students and that at the same time, the environment in which a school is located brings about different responses and behaviours from learner.

Ezeudu et al (2013) in their study on the effect of gender and location on student achievement in chemistry in secondary school in Nsukka local government area of Enugu state, Nigeria reported that there is no significant difference in the academic achievement of student in both urban and rural schools.

The Laboratory-Based Instructional Strategy could perhaps have serious impact on students attitudes towards Chemistry,. It was in the light of this unpleasant occurrence that this study was set out to investigate the Effects of Laboratory-Based Instructional Strategy on Secondary School Students' Attitude towards Chemistry in Ekiti State, Nigeria.

The following questions were raised for the study.

Research Question 1: What is the effect of laboratory-Based Teaching Strategy on students' attitude towards Chemistry?

The following null hypotheses were formulated for the study.

Hypothesis 1: There is no significant difference in the attitude of students exposed to laboratory-based instructional strategy and conventional methods before and after treatment

Hypothesis 2: There is no significant influence of location on the academic performance of students exposed to Laboratory=Based Instructional Strategy.

Research Instruments

1. Chemistry Achievement Test (CAT)
2. Questionnaire on Students' Attitude towards Chemistry (QSAC)
3. Teacher's Instructional Guide on Laboratory

RESULTS AND DISCUSSION

The results contain the descriptive analysis of the data collected to answer the research questions, as well as hypotheses testing.

Results

Descriptive Analysis of Research Questions

Research Question 1: What is the effect of laboratory-based instructional strategy on students' attitude towards Chemistry?

Table 1: Mean and Standard Deviation of Effect of Laboratory Method of Teaching on Students' Attitude Towards Chemistry

Strategy	Test	N	Mean	S.D	Mean Diff.
Laboratory	Before Treatment	74	71.88	2.10	33.58
	After Treatment	74	105.46	3.72	

Table 1 shows the mean pre-treatment and mean post-treatment scores of attitude of students exposed to laboratory method. The mean pre-treatment score of attitude of students was 71.88 while mean post-treatment score of attitude of students was 105.46. The Table above shows that the mean difference in students' attitude in Chemistry between pre-treatment and post-treatment scores for laboratory method was 33.58. The graphical representation below further shows the effect of laboratory method in eliciting students' attitude towards Chemistry.

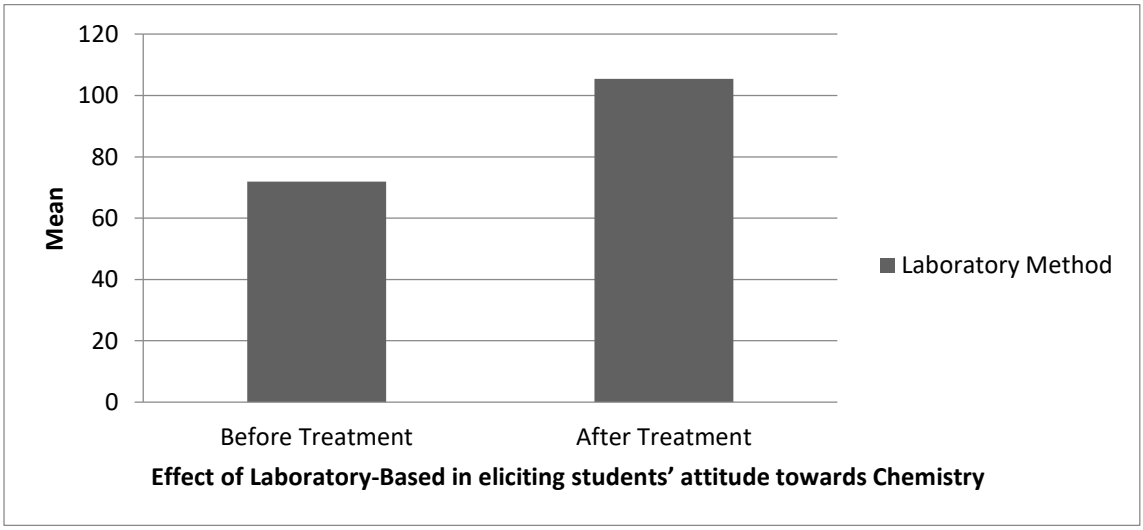

Figure i: Bar Chart Showing Effect of Laboratory-Based Teaching Strategy on Students' Attitude towards Chemistry?

Testing of Hypotheses

Hypothesis 1: There is no significant difference in the attitude of students exposed to laboratory-based instructional strategy and conventional methods before and after treatment

Table 2: Analysis of Covariance (ANCOVA) for Attitude of Students Before and After Treatment Under the Groups

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11660.713[a]	2	5830.356	652.349*	.000
Intercept	980.188	1	980.188	109.672*	.000
Pre-Attitude	.169	1	.169	.019	.891
Groups	11571.706	1	11571.706	1294.740*	.000
Error	1170.809	131	8.937		
Total	**1275190.000**	**134**			
Corrected Total	**12831.522**	**133**			

a. R Squared = .909 (Adjusted R Squared = .907) *P < 0.05

Table 6 shows pre-attitude P value = 0.891>0.05, this implies that there was no significant difference in the attitude of students in the groups before treatment. The result also presented in Table 6 shows F-value of 1294.740 is significant because the p-value of 0.000 is less than 0.05 level of significance. This result led to the rejection of the null hypothesis. By implication, there was significant difference in the attitude of students exposed to laboratory and conventional methods before and after treatment.

Hypothesis 2: There is no significant influence of location on the academic performance of students exposed to Laboratory=Based Instructional Strategy.

Table 3: Two-way Analysis of Variance (ANOVA) for Influence of Location on Academic Performance of Students Exposed to Laboratory-Based Instructional Strategy.

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	33.677[a]	4	8.419	37.945*	.000
Intercept	5.912	1	5.912	26.645*	.000
Location	.081	1	.081	.367	.547
Performance	7.756	1	7.756	34.957*	.000
Location* Performance	.000	1	.000	.002	.966
Error	15.310	69	.222		
Total	**18961.000**	**74**			
Corrected Total	**48.986**	**73**			

a. R Squared = .687 (Adjusted R Squared = .669) * P < 0.05

Table 8 shows that the F-cal value of 0.002 is not significant because the P value (0.966) is greater than 0.05. This implies that the null hypothesis is not rejected. Hence, there was no significant influence of location on the academic performance of students exposed to laboratory method of teaching.

Discussion

The study indicated that there was no significant difference in the pre-test mean score and attitude of students exposed to laboratory-based and conventional methods. The performance, and attitude of students in both experimental and control groups were low and do not differ statistically. This finding established the homogeneity of the two groups involved in the study prior to the experiment. In other words, it could be said that the knowledge baseline, and attitude for the two groups involved in the study are equal. Consequently, any significant difference recorded afterwards would not be ascribed to chance, but to the specific treatment applied.

The study shows that there was significant difference in the pretest and post-test mean score of students exposed to laboratory and conventional methods. There was a better improvement in the attitude of students resulting from their exposure to laboratory-based instructional strategy. This study agrees with the findings of Omotayo (2016) that application of laboratory method yielded better results than the conventional method because, it gives flexibility for students' learning in terms of learning style and study time, it improves students' experience and enhances their engagement. The findings of this study revealed that there was significant difference in the attitude of students exposed to laboratory-based and conventional methods after treatment. Students exposed to laboratory-based instructional strategy showed good attitude towards learning of Chemistry than those in the conventional group because, it integrates the use of face

to face and demonstration which facilitates proper assimilation and comprehension.

The study also pointed it out that there is no significant influence of location on the academic performance of students exposed to laboratory-based method. By implication, laboratory-based instructional strategy is not location biased because location of the student has no influence on their academic performance when taught Chemistry using laboratory-based method of teaching. This result supports the findings of Kolawole and Olofin (2018b) who concluded in their study that there is no significant difference in the performance of students in rural and urban settings. But the result contradicted the findings of Oginni, Awobodu and Alaka (2013), who concluded that students in urban settings performs better than their counterparts in rural settings because of the favourable environmental setting.

Summary

The findings from the analysis are as follows

1. There was significant difference in the attitude of students exposed to laboratory-based instructional strategy and conventional methods before and after treatment
2. There was no significant influence of location on the academic performance of students exposed to laboratory-based instructional strategy.

Conclusion

Based on the findings of this study, it could be concluded that, the use of Laboratory-Base Instructional Strategy enhanced student's attitude towards Chemistry. That shows that Laboratory-Based Instructional Strategy is more effective. Laboratory-Base Instructional Strategy is not gender biased and potent in all locations.

Recommendations

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

1. Teacher should be encourage to develop the attributes of using laboratory-Based Instructional Strategy in teaching Chemistry in the secondary schools so as to enhance better academic performance of students, attitude towards Chemistry.
2. Government should provide more laboratory equipment to schools to facilitate teaching-learning process.
3. There should be regular assessments and training for the science teachers especially Chemistry Teachers.

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EMPOWERING WOMEN FOR NATIONAL SECURITY AND DEVELOPMENT IN NIGERIA: CHALLENGES AND OPPORTUNITIES

BY

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Abstract

The triumvirate factors of National security, good governance and development are in separable concepts for peace and progress of any nation. The goal of any democracy is to attain the aforementioned factors and sustain them. The simple definition of democracy is the government of the people, by the people and for the people. This underscores the importance of the people, irrespective of their gender as the social oxygen of the political process. Regrettably, in the present domain of a sexist world, women participation in national security, good governance, social and economic development have been acutely curtailed by male chauvinism fostered by the patriarchal system in many parts of the world. In many advanced nations, women were, until recently disenfranchised from the political process. This was the case in the suffragette of the 17th and 18th centuries. In the United States of America, until the Susan Anthony amendment of 1949, women were not allowed to vote. The story is far more pathetic in less developed and poorer countries of the world. The need for paradigm shift in women involvement in national security good governance and development in developing economy such as Nigeria is the kernel of this paper. This paper therefore examined the role of women in the political process. Attempts were made to critically examine and engage factors militating against women participation in national security, good governance and development. The method is historical and descriptive in nature. The way forward in this social logjam is proffered.

KEY WORDS: Security good governance, development and women participation.

INTRODUCTION

The participation of women in the affairs of a nation is of growing concern in the society. Nigeria has a rich history of women who participated in active politics, during the pre - colonial era. History recorded the exploits of great women who fought hard for women's rights and dignity. For example, Queen Amina of Zaria, who led armies to drive out invaders from Zaria, and Moremi of Ile-Ife, whose sacrifice for her people was of great benefits to many. Others include Margaret Ekpo, a civil rights activist and Funmilayo Ransome Kuti who led the Egba women, on a protest against taxation. Also, Aba women riot of 1929, and Iyalode Tinubu of Lagos, who encouraged the economic activities of women during her life time, and a lot of other women who at one time or the other contributed immensely to the growth and development of the

country. The legacies these women left behind are at the risk of extinction as majority of Nigerian women are offered minimal participation in the democratic process. The positions offered to them are not commensurate with the proportion of women, in terms of population.

In the country, female participation is far from what obtains in the western world. Some consensus have it that Nigerian security is in the hand of those who possess the wherewithal to take it by force and, that means those that can march violence with violence. This belief that men possess the superiority, strength, competitiveness that can make them excel in political endeavour is a myth as women are considered passive to engage in the do or die politics of the nation conversely. The legacies of these women are at the risk of extinction if majority of Nigerian women are disadvantaged to minimally participate in national security and good governance. The current level of women involvement in national security, and good governance is not commensurate with the proportion of women in the country. This archaic belief is also constructed by societal norms and values which through socialization defined gender roles according to biological differences. Women's perception of participation in governance as a dirty game and orgy of has further alienated them from governance.

Women have always participated in productive labour and their numerical strength in the labour market has been on the increase, but their presence and impact has been very insignificant in governance. Olusola (1998) cited by Fapounda (2008) opined that women by their sheer psychological, physiological and intellectual make up perform more than mere complementary roles in the production process. The low appearance of women in national security, good governance and development emanates from gender stereotype and wrongly defined sex roles. Religious institution does not help the matter as some religious practice do not support effective participation of women in the society. For example, the Christian religion, compel women to be submissive to her husband in all areas: Ephesians Chapter 5, verses 22-23. Equally, the Islamic doctrine support that women should be submissive to their husbands in all area of endeavor. Also in the traditional setting, women are not supposed to be heard in the public. This is to say that in religious institution, women are responsible to the men. This has also limited the manifestation of women in activities in the social environment.

Recently, women begin to play increasing roles in the development of the society, as a result of technological change and dynamic nature of the environment. In social studies education. the contemporary issues in social studies education like gender equity, women empowerment and the likes have brought awareness to the importance of women in the society. We have women as Senators, Deputy Governors, Vice – Chancellors, Chairperson of Local Governments and other important leadership positions.

Role of Women in National Peace and Security

Women play important roles in national security, good governance and development. According to Fapounda (2008), the importance of women's participation in conflict resolution, peace building and conflict settlement is tie fulcrum of President Obama's National Security strategy, and USA recognizes that countries are more peaceful and prosperous when women are accorded equal rights and opportunity. When those rights and opportunities are denied, countries often lag behind. Also, women and girls often disproportionately bear the burden of crises and conflict. In many developed countries especially in the United States of America, the Government support the accelerated

implementation of four security council resolutions on women, the resolution support that women need to be included at the negotiating table and to participate in peace building efforts. For clarity the United Nations resolution are as stated below, as cited by http://womenpeacesecurity.org.

- Advocating to include issues of concern to women and their families in peace and reconstruction efforts.
- Meeting with women organizations, particularly in countries affected by conflict, to hear views and to raise their concerns with host government.
- Identifying and training key women leaders by arranging meetings, seminars, V conferences, and including women participation in USAID and other programmes.
- Encouraging governments to increase the number of female military and police personnel.
- Engaging non- traditional allies including religious leaders of all faith as partners.
- Working with governments of countries in conflict, as well as other humanitarian actors, so that they take special measures to protect women and girls from sexual violence.
- Collaborating with other donour countries on efforts to involve women in all phases of peace building. These efforts are directed to respecting women's rights, safe guarding them from sexual and gender-based violence in armed conflicts and recognizing the critical role of women in peace and security.

In line with the above resolution, women of all status and ages should be informed or equipped by the government to make these recommendations work in order to become effective and efficient in governance. Kudos to the administration of President Goodluck Jonathan who not only complies with the above recommendations. But continues to give our women opportunities to participate in government and affairs of the nation, Olusola (1998).

Nevertheless, there is still room for more women participation in national security and development.

Reasons for low participation of women in national security, good governance and development

The result of the global attention on the need for greater participation by women in national security and good governance is slower due to gender prejudice, poor perception of women's role, lack of financial resources, and institutional insensitivity. These continue to impede women's access to and participation in democracy. Changes in how parliaments operate in developed world reflect the positive impact of the presence of women, such as an improvement in the language and behaviour in parliaments, a different priorization of issues and policies, gender sensitivity in all aspects of governing, including budgeting and the introduction of new legislation and changes to existing laws. (Blanchfield, 2011)

Women involvement in decision making is giving significant political visibility to women's rights worldwide (UN. Women, 2015). Women also support other women and have been instrumental in placing women issue and concern on to the parliamentary agenda. Government has also eliminated all forms of violence against women. Other factors on gender improvement, according to Odane (2010) include; Natural status of women, Cultural practices; Barrier imposed on women where they are to conform and confuse themselves to male dominance and female observance. They are seen in the home incapable of making sound decisions; violence, thuggery, and intimidation other impediments preventing them patriarchal dominance in political parties, godfatherism, indigeneship, rigging, violence and thuggery, Nature

of political formation. This usually happen when meetings are arranged by male friends and business partners, inadequacy of willing and educated women, some women subject themselves to domestic activities, and the need to prevent broken home. High cost of election, Issue of indignity, violence and threat, funding, poverty, viewed from the perspective of these factors, women face massive resistance from participating in national security, governance and development.

Opportunities for effective women participation in National security, good governance and development

Women's participation in decision making positions can lead to more inclusive and representative governance. It can also bring new insight and approaches to national security, governance and development.

Olukeye (2025) opined that women participation in decision making process in any organization increases trust, promoting gender equality and improved outcomes such as economic growth and development, peacemaking and good governances.

Conclusion

The participation of women in national security, good governance and development according to Adebayo (2024) is crucial for teaching sustainable development, promoting peace and stability ad also ensuring effective decision making. Despite the problems ad barriers that women face their involvement in national development cannot be underestimated. To encourage and promote women's effective participation in national development and security, it is important to address the problems and gaps faced by the women and profer solutions to them. It is also essential to harness the full potential of women to contribute effectively to national security, good governance and development, the crush of which this paper seeks to address. It is argued that the exclusion or minimal women participation in matters affecting the nation stunts development and induce poverty.

It is high time women are treated as agents of change in peace and security proce4ss, and not as agents of change in peace and security process, and not as victims who are vulnerable. As agent, women play important roles in ensuring peace and security in Nigeria and also play important roles as agents and actors in the peace building processes. They also play significant roles as mothers, educator, mediators, community leaders and peace activists.

Government should start treating women as agents of peace and security by providing fund and capacity building to women at the local, national and international levels in order to acquaint them with peace and security knowledge to fully participate in conflict mediation, prevention and management.

Recommendation

Esther (2019) listed some ways forward to promoting women's participation in peace and security as follows:

i. Increase in rosters of qualified women to complement a number of capacity building measures for women leadership, mediation, negotiation and election observation to promoting and contributing to peace and security.
ii. Government support for women's participation in peace and security involvement in all sectors of government levels.
iii. There is need to provide funding and capacity building to women on peace and security issues at local, states and national level, in order to acquaint them with that will enable their fall participation in conflict prevention, peace management and reconciliation practices United Nations security.

To promote women effective participation in national security, good governance and development, the following recommendations are made:

i. Provision of inclusive policies that will allow women have rights to participate effectively in nation building.
ii. Increase representation to encourage women participation effectively in national development.
iii. Government should address the gaps or barriers created by the society making sure that women are adequately represented in their own affairs.

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ASSESSING THE SUITABILITY AND ADEQUACY OF THE NIGERIA CERTIFICATE IN EDUCATION AGRICULTURAL SCIENCE EDUCATION CURRICULUM FOR TEACHER PREPARATION IN NIGERIA

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Abstract
This study assessed the suitability and adequacy of the Nigeria Certificate in Education (NCE) Agricultural Science Education curriculum for teacher preparation in Nigeria. Against the backdrop of agriculture's critical role in national development and food security, the study examined whether the NCE curriculum effectively equips prospective teachers with the necessary knowledge, skills, and competencies to meet current educational and agricultural sector demands. Using a descriptive survey design, data were collected from seven Heads of Department (HODs) and 84 lecturers across public Colleges of Education in South West Nigeria. Two instruments Evaluation Checklist on Content Suitability (ECCSASECASO) and Lecturers' Questionnaire on Content Adequacy (LQCAASEC) were employed. The results revealed that the curriculum content is highly suitable for achieving its predetermined objectives, with all objectives rated to a very large extent (Mean = 3.1–3.4). However, the adequacy of the curriculum in preparing future Agricultural Science teachers was rated only to a large extent (Grand Mean = 2.79). Areas such as climate-smart agriculture, agribusiness, precision agriculture, critical thinking, and industry partnerships were identified as weak points needing enhancement. Although the curriculum provides a solid foundation for teacher education, it lacks sufficient alignment with 21st-century agricultural trends and experiential learning opportunities. The study concludes that while the curriculum is functionally effective, it requires significant enrichment in emerging agricultural technologies and practical applications to ensure comprehensive teacher readiness. Recommendations include curriculum revision, greater emphasis on practical exposure, and enhanced collaboration with the agricultural industry.

Keywords: Curriculum Evaluation, Agricultural Science Education, Teacher Preparation, Curriculum Suitability, Curriculum Adequacy

Introduction

Agriculture serves as the cornerstone of human survival and societal development, providing essential resources such as food, clothing, shelter, and raw materials. It plays a critical role not only in sustaining life but also in shaping cultures and economic systems. In Nigeria and across many developing nations, agriculture is increasingly recognized as a strategic tool for addressing poverty,

unemployment, and food insecurity (Adebayo, Ogunyemi, & Kolawole, 2023). According to Okorie, Eze, and Ibrahim (2021), agriculture encompasses the cultivation of crops and the rearing of animals, including activities like processing, storage, and marketing, all aimed at meeting the needs of society. Furthermore, Yusuf and Salihu (2022) emphasized that agriculture supports both domestic consumption and industrial development, making it vital to national growth. Despite the dominance of the oil sector in Nigeria, agriculture remains a significant component of the real sector and continues to contribute meaningfully to the nation's gross domestic product (GDP) and rural employment (Ibrahim & Oladele, 2023).

Agriculture in Nigeria appears not to have attained its full potential due to some developmental challenges. These shortcomings include the unresponsive agricultural education curriculum to socioeconomic, technological, physical, and environmental changes in the rural sector that could be adaptable for the local context usage. Recognising the need to revamp the nation's agriculture, the Federal government of Nigeria, through the National Policy on Education, sees Agricultural Science, one of the subjects offered in Basic Education and Senior Secondary Schools (Post Basic Education), as a pre-vocational elective and vocational elective subject respectively (Federal Republic of Nigeria, 2013). The ability to impart quality knowledge and skills to the students, especially in agriculture, requires a competent and efficient teacher with good academic and pedagogical background. The National Policy on Education affirms that, for a teacher to teach at the Basic level of education in Nigeria, he or she is required to have a minimum qualification of Nigeria Certificate in Education (NCE) a certificate that is acquired from Colleges of Education in Nigeria (FGN, 2013).

The mandate of the teacher training programme at the NCE level, which is the recognized minimum teaching qualification in Nigeria, is to produce quality teachers for the Basic Education sub-sector (FRN, 2013). The roles of teacher education in sustaining the economy and national security in Nigeria is imperative. It is a known fact that, no nation can rise above the quality of its teachers (FRN, 2013). Oloruntimehin and Akinwande (2023) opined that the success of any plan for improving educational outcomes of any nation depends on the quality of teachers who carry it out, and the quality of the teachers depends on the quality of teacher education available.

Nigeria Certificate in Education (NCE) teachers are trained in different disciplines that cut across different schools in the college, including the School of Vocations, where agricultural science teachers are trained in Agricultural Science education (double major). The contents and other aspects of Agricultural Science Education (double major) are expected to equip the teacher in training in different aspects of agriculture, both in theoretical and practical areas, to enable them teach and impart necessary skills that will develop and equip the young students in the areas of agriculture. Nwankwo (2015) noted that Agricultural Science education is a skill-oriented training and the philosophy of Agricultural Science education programmes of Colleges of Education is tied to the national philosophy of agriculture for self-reliance. Agriculture is an important option and fundamental instrument that can help alleviate Nigeria's unemployment, poverty and hunger. Moreover, the transition from school to work is critical for youths.

Curriculum content of NCE Agricultural Science Education programme is designed to provide both theoretical and practical knowledge to prospective Agricultural Science teachers. The National Commission for Colleges of Education (NCCE) stipulates

a curriculum that includes agronomy, animal science, soil science, agricultural extension, agricultural economics, and mechanization (NCCE, 2020). Despite the comprehensive curriculum, the alignment of course content with modern agricultural trends remains a concern. Studies by Olaitan and Mama (2021) highlighted that, while the curriculum covers fundamental agricultural concepts, there is limited emphasis on emerging areas such as precision agriculture, climate-smart agriculture, and agribusiness entrepreneurship, which are critical for the 21st-century agricultural sector.

The NCCE Minimum Standard (2020) pointed out the following as the objectives of Agricultural Science education:

(i) to prepare graduates with the right attitude to and knowledge/professional competence in vocational agriculture;
(ii) to produce teachers who will be capable of motivating students to acquire an interest in and aptitude for agriculture;
(iii) to develop in the student-teachers the appropriate communicative skills for effective transmission of agricultural information and skills to the students in the context of their environment;
(iv) to equip the student-teachers with adequate knowledge and ability to establish and manage a model school farm effectively, and
(v) to provide a sound background to enhance the student-teachers' academic and professional progression (NCCE, 2020).

The Nigeria Certificate in Education (NCE) Agricultural Science Education programme plays a vital role in preparing qualified teachers for teaching Agricultural Science at the Basic and Secondary school levels. Assessing the suitability and adequacy of the NCE Agricultural Science Education curriculum for teacher preparation is essential, as it contributes to national agricultural development, enhances the Gross Domestic Product (GDP), and addresses critical challenges such as unemployment, hunger, and poverty in Nigeria. This paper examined the suitability and adequacy of the NCE Agricultural Science education curriculum for teacher preparation in Nigeria to achieve the predetermined objectives of the curriculum.

Two research questions were raised to guide the study;

1. To what extent is NCE Agricultural Science Education Curriculum content is suitable for achieving predetermine objectives?
2. To what extent does the NCE Agricultural Science education curriculum content adequately prepare prospective Agricultural Science teachers?

Methodology

This study adopted the descriptive survey research design. The population for this study consisted the Head of Department (HODs) and lecturers from Agricultural Science education department of public Colleges of Education in South West, Nigeria. The sample comprised seven HOD's and all 84 lecturers from the seven public Colleges of Education in South West Nigeria that had established Agricultural Science education programmes before the 2020/2021 academic session. A purposive sampling technique was used to select all seven HOD's and all 84 lecturers from the Agricultural Science Education department. Two research instruments were used to elicit responses from the Heads of Department (HODs), and Lecturers in the Agricultural Science Education department. These instruments included, Checklist on Content Suitability of NCE Agricultural Science Education Curriculum in Achieving the Stated Objectives (CCSASECASO), and Lecturers' Questionnaire on Content Adequacy of NCE Agricultural Science Education Curriculum (LQCAASEC) adapted from Alabi (2022).

The CCSASECASO checklist was used to assess the suitability of the

curriculum content in achieving the stated objectives outlined by the NCCE for the Agricultural Science Education Curriculum. This checklist was administered to the HODs of the participating Colleges of Education. The LQCAASEC questionnaire contained items designed to elicit information from lecturers regarding the content adequacy of the NCE Agricultural Science Education Curriculum in preparing prospective Agricultural Science teachers. The extent of alignment with the prescribed standards was measured using the following benchmark scale, 4.0 – 3.1 Very Large Extent (VLE), 3.0 – 2.1 Large Extent (LE), 2.0 – 1.1 Small Extent (SE), and 1.0 – 0.1 Very Small Extent (VSE).

To ascertained the consistency of the contents of the instruments and further improve the reliability of the instruments, the test - re-test method of ascertaining reliability was employed. The instruments were administered on the HOD's, and the lecturers from a sample out of the study area. The instruments were administered twice to the HOD's, and the lecturers from public Colleges of Education (Federal and State) in Kogi State, Nigeria within an interval of three weeks. Then, Pearson product moment correlation analysis was carried out on the data obtained from the administration which yielded reliability coefficients of 0.81 for Checklist on Content Suitability of NCE Agricultural Science Education Curriculum in Achieving the Stated Objectives (CCSASECASO), and 0.89 for the Lecturer's Questionnaire on Content Adequacy of NCE Agricultural Science Education Curriculum (LQCAASEC). The data collected were clean, coded and analysed using descriptive statistics such as means, and standard deviation.

Results

Research Question 1: To what extent is NCE Agricultural Science Education Curriculum content is suitable for achieving predetermine objectives?

To provide answer to this evaluation question, responses from the HODs' who filled the Checklist on Content Suitability of NCE Agricultural Science Education Curriculum in Achieving the NCCE stated Objectives in conjunction with the researcher were collated and analysed. The results were summarized as shown in Table 1.

Table 1: Extent of the Suitability of NCE Agricultural Science Education Curriculum Content for Achieving Predetermined Objectives Based on HODs' Checklist

S/N	Objectives of Agricultural Science Education Curriculum as stated by NCCE	Courses Available to Achieve the Objectives	N	Mean	Standard Deviation	Remark
1	To prepare graduates with the right attitude to and knowledge/professional competence in vocational agriculture	VTE110, AGE111,112, 113, 114, 115, 116, 117, 118, & 119	7	3.3	0.49	VLE
2	To produce teachers who will be capable of motivating students to acquire an interest in and aptitude for agriculture	AGE121, 122, 123, 125, 126, 228, 321, 324, 326, & 329	7	3.4	0.53	VLE
3	To develop in the student-teachers the appropriate	AGE124, 127, 213,	7	3.1	0.38	VLE

	communicative skills for effective transmission of agricultural information and skills to the students in the context of their environment	214, 216, 219, 222, 323, 325, 327, 328, & EDU. 311			
4	To equip the student-teachers with adequate knowledge and ability to establish and manage a model school farm effectively	AGE211, 212, 215, 217, 218, 223, 224, 225, 226, 227, 229, & 322	7	3.1	0.38	VLE
5	To provide a sound background to enhance the student-teachers' academic and professional progression	AGE220, 221, 320, & EDU. 323	7	3.1	0.38	VLE
	Average Weighted Score			**3.2**		**VLE**

Benchmark: Between 4.0 and 3.1 Very Large Extent (VLE); Between 3.0 and 2.1 Large Extent (LE); Between 2.0 and 1.1 Small Extent (SE) and between 1.0 and 0.1 Very Small Extent (VSE)

From the table, all the curriculum objectives assessed received a mean score ranging between 3.1 and 3.4, which falls within the 'Very Large Extent (VLE)' category according to the benchmark scale. This indicates that the courses designed to achieve the objectives are generally seen as appropriate and well-structured for meeting the intended learning outcomes. The highest-rated objective (Mean = 3.4, S.D = 0.53) is the ability of the curriculum to produce teachers who are capable of motivating students to develop an interest and aptitude in agriculture. This suggests that the courses covering this objective, such as AGE 121, 122, 123, and others, are perceived as highly relevant and effective. Of the five listed objectives on the checklist, the last three ranked lowest (Mean = 3.1, S.D =0.38). Although they all still rated within the category of Very Large Extent, their relatively lower means suggest possible areas for curriculum improvement. The average weighted score (3.2, S.D = 0.43) further confirms that, on an overall level, the NCE Agricultural Science Education Curriculum content is to very large extent suitable for achieving its predetermined objectives.

Research Question 2: To what extent does the NCE Agricultural Science Education Curriculum content adequately prepare prospective Agricultural Science teachers?

To answer this evaluation question, responses from the questionnaire administered to lecturers regarding the extent to which the NCE Agricultural Science Education Curriculum content adequately prepares prospective Agricultural Science teachers were collated and analyzed. A summary of the results is presented in Table 2.

Table 2: Extent of Adequacy of NCE Agricultural Science Education Curriculum in Preparing Prospective Agricultural Science Teachers

S/N	Items	N	Mean	S.D	Decision
1	The NCE Agricultural Science Education content is well arranged to achieve the stated objectives.	84	3.20	0.555	VLE
2	The curriculum content of NCE Agricultural Science Education is relevant to the needs of the agricultural Science teacher.	84	3.23	0.449	VLE
3	Courses and subject matter covered in the curriculum content of NCE Agricultural Science Education are comprehensive and up-to-date.	84	2.79	0.713	LE
4	NCE Agricultural Science Education Curriculum content teaches climate-smart agriculture which is critical for the 21st-century agricultural sector.	84	2.43	0.960	LE
5	The content of NCE Agricultural Science Education Curriculum incorporates agribusiness entrepreneurship	84	2.60	0.713	LE
6	The NCE Agricultural Science Education Curriculum content provides opportunities for students to develop problem-solving and critical-thinking skills.	84	2.68	0.697	LE
7	The curriculum content for NCE Agricultural Science Education provides opportunities for students to acquire teaching skills in agriculture.	84	3.27	0.523	VLE
8	The Curriculum content of NCE Agricultural Science are relevant diverse learners' need.	84	2.93	0.555	LE
9	The curriculum content of NCE Agricultural Science Education provides opportunities for students to engage in hands-on, experiential learning.	84	2.83	0.758	LE
10	The NCE Agricultural Science Curriculum content covers precision agriculture	84	2.24	0.913	LE
11	Different curriculum components (e.g., lectures, laboratory, and fieldwork) are well-coordinated and integrated into the NCE Agricultural Science Education Curriculum content.	84	2.93	0.690	LE
12	The practical and field-based learning experiences of NCE Agricultural Science Education content are well-integrated with the theoretical components of the curriculum.	84	2.81	0.570	LE
13	The practical and field-based learning experiences aligned with the stated objectives of NCE Agricultural Science Education Curriculum.	84	2.87	0.510	LE
14	The curriculum content of NCE Agricultural Science Education provides opportunities for students to work with industry partners or mentors	84	2.50	0.784	LE

15	The NCE Agricultural Science Education Curriculum content promotes inclusivity and diversity in Agricultural Science Education	84	2.60	0.713	LE
	Average Weighted Score		**2.79**		**LE**

Benchmark: 0 to 1.00 - Very Small Extent (VSE); 1.01 to 2.00 - Small Extent (SE); 2.01 to 3.00 - Large Extent (LE); and 3.01 to 4.0 - Very Large Extent (VLE)

The responses from lecturers reveal that while the curriculum demonstrates strengths in foundational areas, there are considerable gaps in its responsiveness to emerging trends and practical competencies in agricultural education. A closer look at the data showed that respondents agreed that, the curriculum is well-structured, relevant to teacher preparation needs, and effective in equipping students with core teaching skills. However, the majority of the evaluated items, including those related to climate-smart agriculture, precision agriculture, agribusiness, critical thinking, and industry collaboration were only rated to a large extent. This signals a clear limitation in the curriculum's ability to integrate contemporary agricultural practices and real-world applications. The grand mean score of 2.79, categorized as 'Large Extent', reinforces this finding. It suggested that although the curriculum content provides a solid foundation, it falls short of delivering a fully comprehensive and future-ready training experience for prospective teachers. Above all, the results highlighted a curriculum that is functionally to a large extent but strategically limited in some areas such as; climate-smart agriculture, precision agriculture, agribusiness, critical thinking, and industry collaboration.

Discussion

The findings of this study revealed that the NCE Agricultural Science Education Curriculum content is to very large extent suitable for achieving its predetermined objectives, despite this overall positive alignment, some aspects of the curriculum were perceived as less effective, particularly in areas related to communication skills, farm management, and the provision of an academic foundation for continuous professional development. These findings are in agreement with the submission of Nwosu and Akpan (2020) and Adeyemi and Adebayo (2021) respectively, who highlighted persistent challenges in Agricultural Science teacher training programs, especially in building effective communication and managerial skills. Courses designed to address agricultural communication and extension may require further strengthening to better prepare graduates for real-world interactions with students and agricultural stakeholders.

The feedback also pointed to the need for improved practical exposure, especially in areas related to farm management. This supported the conclusions of Adeyemi and Ogundipe (2018) and Olatunji and Osunde (2023) that many agricultural teacher education institutions continue to emphasize theoretical instruction at the expense of hands-on learning. As a result, graduates may find it difficult to manage school farms effectively or translate classroom knowledge into real-life agricultural practice. These insights underscore a potential gap between the curriculum's theoretical design and its practical application. Bridging this gap could involve introducing more farm-based internship opportunities, enhancing industry collaboration, and revising existing courses to emphasize experiential learning.

The findings from the study further revealed that while the NCE Agricultural Science Education

Curriculum provides a solid foundation in pedagogical content and basic agricultural knowledge to a large extent, it falls short in preparing prospective teachers with competencies required for modern agricultural practices. This aligned with the submission of Igbokwe, Alade, and Nwankwo (2022), who affirmed that the NCE Agricultural Science programme adequately prepares pre-service teachers in core educational content, particularly in traditional instructional delivery and subject-matter understanding. However, the low ratings in curriculum components related to climate-smart agriculture, agribusiness, critical thinking, and industry collaboration raise concerns which suggests that the curriculum is not fully responsive to contemporary demands in agricultural education, particularly in a rapidly evolving agricultural economy. Adebayo and Ogunlade (2021) found similar limitations, noting that most teacher education programmes in Nigeria remain heavily theory-driven, with minimal integration of hands-on and entrepreneurial experiences necessary for 21st-century agricultural productivity. Furthermore, Okoli and Nwachukwu (2020) also argued that agricultural education curricula in Nigeria must evolve to include digital and smart farming innovations if they are to remain relevant and impactful.

Conclusion

The study concluded that the NCE Agricultural Science Education curriculum is, to a very large extent, relevant to national educational goals by equipping graduates with foundational pedagogical and agricultural knowledge. It supports the mandate of training competent teachers for the basic education sector and fosters student interest in agricultural careers. However, the curriculum's limited alignment with current global and technological trends such as climate-smart agriculture, agribusiness, and digital innovation reveals a gap in its responsiveness to the evolving context of agricultural development.

Recommendations

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

1. The NCE Agricultural Science Education Curriculum should be urgently reviewed and updated to reflect emerging global trends in agriculture, including climate-smart agriculture, precision farming, digital agriculture, biotechnology, and agribusiness.
2. Core components promoting 21st-century skills such as entrepreneurship, digital literacy, communication, critical thinking, and problem-solving should be fully integrated into the curriculum.
3. The curriculum should be aligned with national agricultural development policies, Sustainable Development Goals (SDGs), and current labour market demands to ensure relevance and employability of graduates.
4. Practical modules such as Supervised Farm Practice (SFP) and Student Industrial Work Experience Scheme (SIWES) should be restructured to ensure standardization, consistency, and better coordination across institutions.
5. Institutions should develop clear frameworks and allocate adequate funding to support the implementation of practical activities and field-based projects.

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ANALYSIS OF QUANTITATIVE AND QUALITATIVE APPROACHES IN GEOGRAPHY AND ENVIRONMENTAL EDUCATION IN NIGERIA TERTIARY INSTITUTIONS

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Abstract

One of the key factors in the success of Environmental Education and Geographic research is not just the applicability of both quantitative and qualitative methods, but the manner and techniques of incorporating the approaches in geography and environmental education. It entails careful planning to ensure that the approaches are well thought out and applied in Geographic studies. The approach considered for any geographic research must be thoroughly selected for use, and it must be appropriate for the overall purpose, learning objectives and research intent in which it is to be integrated. The integration of quantitative and qualitative approaches is crucial for creating immersive and personalized experiences in Geography and Environmental Education. They have the potential to revolutionize environmental education and geographic research through adaptive learning, intelligent interactions and realistic data gathering. This paper analyzes the quantitative and qualitative approaches in geography and environmental education. It sought to examine the key aspects and techniques the approaches follow in data gathering and generalization, bearing in mind the components of statistical analysis, spatial analysis, statistical modeling, GIS, remote sensing, and the application of oral history, participatory mapping, as well as observation techniques. The study further contends that integrating the approaches enhances research skills, promotes critical thinking as well as preparing students for diverse career opportunities. The paper concludes by underscoring the immense potentials of quantitative and qualitative approach, even as they offer distinct, yet complementary perspectives to Geography and Environmental Education.

Keywords: Analysis, Qualitative, Quantitative, Geography Education, Tertiary Institutions.

Introduction

As Geography is a multidisciplinary science, it is quite natural that students and teachers tend to perceive and describe geography with different perspectives, which appears to have something to do with the fact that geography has a structure that can be positioned in accordance with academic field and various viewpoints. Due to their differing perceptions of, and approaches to geography, many geographers have defined it in a different way. For instance, whilst Ilzgen (2021) perceives geography as man's effort to govern the environment, Cresswel (2018) took geography as strategic information required for political and military applications. Still, other Geographers as Gregg and Leinhardt (2024) observed Geography as a combination of knowledge and opinions on the distribution of topographic features, their historical developments, and their formation in time.

Geographers who have called attention to the interaction between man and environment have defined geography as a scientific field that explains the mutual interactions between man and natural environment as well as their spatial patterns (Ilzgen, and Bindak, 2019; Lambert & Morgan, 2020). In fact, this kind of definition may well be considered as a reflection of the perceptions regarding the concept. Furthermore, as was mentioned by Bennetts in (2022), this approach has been adopted by a growing number of Geographers. According to this approach, geography is essentially the discipline concerned with the study of physical and human environments and processes; relationships between people and environments; the character of places and landscapes; the significance of location and of spatial patterns, interactions and interrelationships on the Earth's surface; and the relevance of place, space and environments for human welfare.

The skills, techniques, and methods in quantitative and qualitative approach to the teaching of Geography is vital in higher institutions for improved academic performance among students (Gomez, 2020). Appreciation of quantitative and qualitative methods does not begin and end with advanced institutions of learning. For this purpose, quantitative methods were defined by Flowerdew, (2022) to broadly mean data collection, analysis and presentation (which includes GIS and Remote Sensing). A better descriptor would be quantitative skills and processes, which Geographers take to include the learning of computer and data handling skills to process, combine, analyse and present data, and also the ability to think critically (not merely negatively) about quantitative approaches - to take informed and professional judgements regarding statistical analysis and modelling. It is this wider view that Geographers have in mind as the target for learning among geography students.

Quantitative Approach to the Teaching of Geography and Environmental Education

According to Cloke, (2024), Quantitative geography is a subfield and methodological approach to geography that develops, tests, and uses scientific, mathematical, and statistical methods to analyze and model geographic phenomena and patterns. It aims to explain and predict the distribution and dynamics of human and physical geography through the collection and analysis of quantifiable data. The approach quantitative geographers take is generally in line with the scientific

method, where a falsifiable hypothesis is generated, and then tested through observational studies (Cloke, 2024). This has received criticism, and in recent years, quantitative geography has moved to include systematic model creation and understanding the limits of their models.

This approach is used to study a wide range of topics, including population demographics, urbanization, environmental patterns, and the spatial distribution of economic activity (Delyser, 2020). The methods of quantitative geography are often contrasted by those employed by qualitative geography, which is more focused on observing and recording characteristics of geographic place. However, there is increasing interest in using combinations of both qualitative and quantitative methods through mixed-methods research to better understand and contextualize geographic phenomena.

Quantitative approach in Geographic knowledge refers to the systematic scientific investigation of quantitative properties and phenomena and their relationships, by using statistical methods (Hay, 2023). It includes the analysis of numerical spatial data, the development of spatial theory, the construction and testing of mathematical models of spatial processes. Since the early 1990s the interest in georeferenced data and the need to understand, it has led to an enormous field of spatial analysis. By the late 1990s, the field of spatial analysis had matured to the point where the methods of spatial analysis served as fundamental research techniques in a variety of disciplines, including geography, ecology, environmental studies, epidemiology, regional science, sociology, and urban planning. The quantitative methods of yesteryear have given way to a complex field of spatial analysis that serves as a unifying methodology for social science in general.

Applicable Techniques in Quantitative Geography

The quantitative technique in Geography involves using numerical data, statistical methods, and mathematical models to analyze and understand geographic phenomena, geographical patterns, and relationships. These techniques help geographers to quantify observations, test, hypotheses and make predictions about geographical phenomena. Hay, (2023) suggested the various ways it can be applied:

Statistical Analysis: It takes the form of:

i. **Descriptive Statistics**: It involve using measures such as mean, media, mode and standard deviation to analyze data.
ii. **Inferential Statistics**: Involves making predictions or inferences about a population based on a sample, using techniques like hypotheses testing and confidence intervals.

Spatial Analysis: According to Cloke (2024), spatial analysis involves using statistical techniques to analyze spatial patterns and relationships in geographic data. It includes:

i. **Geostatistics** techniques such as kriging to analyze and interpret spatially correlated data.
ii. **Spatial Autocorrelation** Involves measuring the degree to which a set of spatial features and their values are correlated to each other across space.

Geographic Information Systems (GIS): GIS utilizes software to collect, analyze, and visualize geographic data. It considers:

i. **Spatial Data Analysis**: Using GIS software to analyze spatial data, including overlay analysis, buffering and spatial querying.
ii. **Mapping and Visualization**: It implies creating maps that visually represent quantitative data, allowing for easier interpretation of patterns.

Remote Sensing: Remote sensing adopts technologies to collect data on the Earth's surface and analyze environmental changes, without

necessarily coming in contact with objects or phenomena. Cloke, (2024) stated that it adopts techniques as:

i. **Image Analysis:** Using satellite imagery or aerial photographs to gather quantitative data on land use vegetation cover, and environmental changes.
ii. **Change Detection**: Analyzing temporal changes in land cover or land use, using quantitative methods.

Statistical Modeling and Simulation: Developing statistical models to understand and predict geographic phenomena. It takes into consideration:

i. **Regression Analysis:** Hay, (2023) stated that regression analysis explores relationships between variables to predict outcomes (e.g., simple linear or multiple regression to assess factors influencing land use).
ii. **Spatial Interaction models**: Analyzing flows between locations, such as migration patterns or trade relationships.
iii. **Time Series Analysis:** It entails examining trends and patterns over time in geographical data, such as climate data or population changes.
iv. **Multivariate Analysis**: It examines techniques such as cluster analysis and principal component analysis (PCA) to identify patterns and relationship among multiple variables.

Qualitative Approach to the Teaching of Geography and Environmental Education

Cresswell, (2018) opined that Qualitative geography is a subfield and methodological approach to geography focusing on nominal data, descriptive information, and the subjective and interpretive aspects of how humans experience and perceive the world. Often, it is concerned with understanding the lived experiences of individuals and groups and the social, cultural, and political contexts in which those experiences occur. Thus, qualitative geography is traditionally placed under the branch of human geography; however, technical geographers are increasingly directing their methods toward interpreting, visualizing, and understanding qualitative datasets, and physical geographers employ nominal qualitative data as well as quantitative. Furthermore, there is increased interest in applying approaches and methods that are generally viewed as more qualitative in nature to physical geography, such as in critical physical geography.

While qualitative geography is often viewed as the opposite of quantitative geography, the two sets of techniques are increasingly used to complement each other (Fotheringham, 2015). Qualitative research can be employed in the scientific process to start the observation process, determine variables to include in research, validate results, and contextualize the results of quantitative research through mixed-methods approaches. Pryke (2023) asserted that much of the current qualitative scholarship in geography can be characterized as inductive or descriptive, theory-building work. In understanding human experience, Fisher (2023) reported that qualitative methods aim to be holistic and to articulate actual causes of events or phenomena, thus preserving the context of "data" in collecting and producing evidence. By contrast, quantitative work aims to be deductive or hypothesis-driven, testing data to generalize. But qualitative methods can be designed to test hypotheses, often relying upon approaches of triangulation (correspondence of evidence across contexts or sources) to generalize.

A complaint shared among many social sciences is that qualitative methods are not explicitly taught or well-articulated, compared to quantitative methods. Perhaps, because of geography's history of "borrowing" methods developed in other disciplines, or because of the complexity of some mixed-method research designs, geographers can be relatively silent about their use of qualitative methods.

But the discipline has contributed to developing these methods in keyways, because of geography's epistemological and ontological commitments to analyze space, place, and scale, and because of its tradition of fieldwork.

During the Age of Exploration and amidst the rise of Enlightenment humanism, early geographers were explorers and natural historians; geography as a discipline evolved in service to the nation-state, cartographically circumscribing territories and describing regions and their resources. Fisher (2023) reported that Geographers articulated a "regional approach" to describe places in the early 20th century, but it was not until the quantitative revolution of the 1960s that geographers more carefully began to articulate qualitative methods in the discipline. "Humanistic" approaches to understanding "sense of place" and "landscape" developed more rigorous methods to analyze qualitative human experience, expanding on a core of fieldwork and interviewing techniques.

The qualitative approach in geography focuses on understanding the meanings, interpretations, and experiences of individuals and groups in relation to geographic phenomena. This approach emphasizes the importance of context, perspective, and narrative in shaping our understanding of the world. According to Shummer-smith (2024), the following are aspects that aid qualitative teaching and research in geography

Interview: An interview is a method of inquiry in which participants are asked a set of questions. It is a face-to-face interpersonal role situation in which one-person (the interviewer) asks another person (the interviewee) questions that are responded to orally (Awotunde and Ugodulunwa, 2014). It can be semi-structured or and structured and can use different mediums (e.g., phone, email, in-person). A semi-structured interview is one in which you have an idea about the types of questions you ask but the order and way you ask the question may vary. A structured interview is a specified set of questions that is asked in the same order using the same words during each interview.

Focus Group Discussion: This is a method in which a heterogeneous population come together in one room to discuss a certain topic of interest (Shummer-smith, 2024). Typically, a facilitator organizes the focus group and will guide the conversation to keep the topic of conversation on track. The strength of this method is the opportunity for free flow of conversation; comments tend to stimulate new ideas and discussion topics. The challenge associated with this method is that it is possible for a few assertive people to dominate the conversation.

Participant Observation: This refers to when a researcher embeds him- or herself in the research context by becoming an active participant. In this, the observer is part of the setting in which observation is taking place. For example, a nursery schoolteacher who is interested in studying the patterns of interaction among nursery school children, can conduct the study in his/her school using observation as a major technique for data collection. In this case, the teacher is part of the setting in which observation is carried out.

Survey: This method uses a set of written questions that the participants answer directly on paper or online. According Awotunde and Ugodulunwa, (2014), surveys are very much like census. However, the two differ in that a survey examines a sample from a population, while census enumerates an entire population. Contemporary survey research can be said to be a product of American researchers and their development work in some sectors of American society.

Oral history: This is the process of gathering and listening to people tell their stories and share knowledge. It refers to a spoken account of a witness, or a participant in events of potential historical significance. This

evidence can be obtained through a recorded personal interview, which has been recorded when an eyewitness related his/her experience. Ballads, tales, sagas and other forms of oral tradition are also useful in conveying records of events for posterity. According to Shummer-smith (2024), traditionally oral histories were passed down through generations, building the knowledge bases of communities. Oral histories are often recorded so that both the information, as well as the voices and character of the story telling, can be preserved.

Participatory Mapping: Sometimes called sketch mapping, this is asking a set of questions and having the participants draw how they view the world in a map form. It is typically done using a piece of paper but could be done using digital free drawing applications.

Journalism: When a researcher or a participant documents his or her thoughts feelings or ideas on a topic on a regular basis, it is referred to as journaling. Journaling is a free-flow writing exercise.

Content analysis: This method collects content in multimedia formats from the media, policy documents and other outlets and then codes the material for common themes and ideas.

Qualitative Data Analysis: Qualitative data is collected via the methods described above and then is often transcribed and thematically coded. This means a researcher will read the transcript to identify common themes. There are multiple strategies to code qualitative data, either by formulating codes prior to collection it and reading transcripts, or by the researcher identifying common themes that emerge from the data.

Interpretive Analysis: Analyzing texts, images, and other data sources to understand the meanings and interpretations of geographic phenomena.

Case Studies: Conducting in-depth examinations of specific cases or locations to gain a nuanced understanding of geographic issues.

Ethnographic Research: Using ethnographic methods, such as participant observation and interviews, to study the experiences and perspectives of individuals and groups.

Narrative Analysis: Analyzing stories and narratives to understand how people make sense of their geographic environments.

Implications of Quantitative and Qualitative Approaches to Geography Education

Quantitative and qualitative techniques are applied in various areas of geography and environmental education, including urban planning, environmental studies, transportation, and regional development, allowing geographers to make data driven decisions and policies (Shummer-smith, 2024). These methods enable geographers to provide empirical evidence for their findings and helps to contribute to a more rigorous understanding of spatial phenomena. The integration of qualitative and quantitative approaches in geography and environmental education has several implications:

Enhances Research Skills: Students learn to design and conduct research projects that combine quantitative and qualitative methods. Also, students develop skills in analyzing and interpreting different types of data, including numerical and narrative data.

Stimulates Critical Thinking and Problem-Solving: Students learn to critically evaluate different methodologies and approaches. Similarly, students develop skills in applying different methods to complex geographic problems.

Developing versatile researchers: Educating students in both quantitative and qualitative approaches enables them to tackle a wide range of research questions and problems.

Preparing students for diverse careers: Equipping students with both

quantitative and qualitative skills prepares them for careers in research. Specifically, students are prepared for careers in policy, industry, and community development. Equally, students learn to work across disciplines, combining geography with other fields like environmental science, economics, or sociology.

Quantitative approaches aren't inherently more effective than qualitative approaches; they serve different purposes and offer distinct strengths (Gomez, 2020). Quantitative approach excels at analyzing large datasets, identifying patterns, trends, and correlations through numerical data. It is useful for hypothesis testing, predictive modeling, and generalizability. On the other hand, qualitative approach Provides an in-depth, nuanced insights into complex phenomena through non-numerical data (e.g., text, images, observations). It is useful for exploring contexts, meanings, and experiences. Gomez, (2020) asserted that both approaches can be complementary as they adopt the mixed-methods research, which combines quantitative and qualitative methods to achieve a more comprehensive understanding. Also, they are context-dependent, that is they possess the effectiveness to depend on research questions, objectives, and the nature of the phenomena being studied. Ultimately, the effectiveness of an approach depends on its alignment with research goals and questions.

Conclusion

The study of geography in higher education institutions benefits significantly from both qualitative and quantitative approaches. These two methodologies offer distinct yet complementary perspectives on understanding geographic phenomena. While Quantitative approach provides data-driven insights, objectivity, and predictive power, enabling researchers to analyze spatial patterns, model geographic phenomena, and make informed decisions. Qualitative Approach on the other hand offers an in-depth understanding, contextualized knowledge, and diverse perspectives, allowing researchers to explore the meanings, interpretations, and experiences of individuals and groups in relation to geographic phenomena. By combining quantitative and qualitative methods, researchers can triangulate findings through the Validation of results by cross-verifying data from different sources and methods. Both students and teachers can gain a more comprehensive understanding through the Integration of numerical data with narrative insights to develop a richer understanding of geographic phenomena. Finally, complex research questions can be addressed through a mixed-methods approach to tackle complex research questions that require both quantitative and qualitative data.

Recommendations

1. Nigerian tertiary institutions should regularly review and update their geography and environmental education curricula to incorporate both quantitative and qualitative approaches, ensuring students are equipped with a comprehensive understanding of environmental issues and research methods.
2. Tertiary institution educators should receive training and capacity building opportunities to enhance their skills in both quantitative and qualitative research methods, enabling them to effectively teach and mentor students in these areas.
3. Geography and environmental education departments should foster interdisciplinary collaboration with other departments, such as environmental science, sociology and economics, to promote a holistic understanding of environmental issues and develop innovative solutions to complex problems.

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DEVELOPMENT OF BIOLOGICAL GARDENING SKILLS AND ENHANCED ACADEMIC PERFORMANCE THROUGH STEM-BASED LEARNING AMONG NCE STUDENTS, NORTH-WEST, NIGERIA

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Abstract

This study explored the development of biological gardening skills and enhanced academic performance through STEM-based learning among Nigerian Certificate in Education (NCE) students in Zaria, Nigeria. The study employed a quasi-experimental, non-randomized pre-test-post-test control group design involving 135 NCE pre-service biology students from two federal colleges of education in northwest Nigeria. The experimental group engaged in hands-on biological gardening activities for six weeks, while the control group received traditional classroom instruction. Data were collected using the Biology Garden Concept Performance Test (BGCPT), a 25-item multiple-choice assessment, and analyzed using mean, standard deviation, and t-test. Results indicated that STEM-based learning significantly improved students' biological gardening skills and academic performance. The experimental group achieved a higher mean post-test score (M = 28.33) compared to the control group (M = 18.98), with a statistically significant effect ($p < 0.05$). There was an improvement in the acquisition of STEM-based biological gardening skills. Gender differences were negligible, with females slightly outperforming males, suggesting equal benefits for both genders. The study recommends that the National Commission for Colleges of Education should incorporate STEM-based approaches into biology education curricula to enhance the acquisition of biological gardening skills and academic performance, among others.

Keywords: Development, Biological Gardening, Skills, Enhanced, Academic Performance, STEM-Based Learning.

Introduction

In our rapidly evolving technological era, science education serves as the cornerstone of national development (Aithal & Maiya, 2023). Beyond workforce preparation, scientific literacy determines a nation's economic competitiveness and geopolitical

influence. Among scientific disciplines, biology occupies a unique position - bridging theoretical knowledge with practical applications in medicine, agriculture, and environmental conservation (Izah & Ogwu, 2023). However, traditional pedagogical approaches often fail to translate classroom concepts into real-world competencies (Okpara, 2024), creating a critical gap in science education. Biological gardens emerge as transformative educational spaces that address this challenge.

According to Kalgi, & Hire (2024) biological gardens are planned and maintained outdoor space where plants such as flowers, vegetables, herbs, and trees are grown. Stagg, Hetherington & Dillon (2025) added that they range from small home gardens to large botanical gardens to school gardens. School gardens are considered open-air laboratories for students. These living laboratories (Kalgi & Hire, 2021) provide an ideal platform for integrated STEM learning, where students investigate plant biology and ecosystem dynamics (science), implement smart irrigation and monitoring systems (technology), design sustainable garden layouts and composting solutions (engineering), and calculate growth metrics and resource requirements (mathematics). This hands-on approach cultivates not only academic mastery but also essential life skills, environmental stewardship, patience, and responsibility (Bwegyeme & Munene, 2021). Research confirms that such experiential learning significantly enhances knowledge retention and practical problem-solving abilities (Zuiker & Riske, 2021).

The development of these competencies is particularly vital for NCE students. As future educators, they must embody both subject mastery and sustainable practices to effectively nurture environmental consciousness in their students (Hogan & O'Flaherty, 2021). STEM-based biological gardening offers an ideal framework for this dual development, merging theoretical understanding with actionable skills. Projects such as creating automated plant watering systems and analyzing garden ecosystem data help students connect classroom concepts to tangible outcomes. This method not only improves academic performance but also fosters innovation, teamwork, and practical skills that students can apply beyond the classroom (Tariq, 2024). This approach cultivates a new generation of learners who can think critically, solve problems creatively, and contribute to sustainable development in their communities. The integration of science, technology, engineering, and mathematics through practical applications creates a powerful learning environment that prepares students for the challenges of the modern world. Asogwa (2024) highlights that biological gardens provide a hands-on, multidisciplinary approach to STEM education by combining science, technology, engineering, and mathematics to understand soil chemistry, plant biology, ecosystems, and climate change. This is achieved through the use of hydroponics, intelligent irrigation systems, composting systems, water-saving methods, efficient garden designs, space management, fertilizer ratio calculations, and plant growth monitoring.

Despite these demonstrated benefits, a significant research gap persists regarding STEM-based gardening interventions for Nigerian teacher trainees. This study specifically intends to examine how integrated STEM gardening activities impact both skill development and academic performance among NCE students in Northwest Nigeria.

Statement of the Problem

Science education in Nigeria struggles to connect theoretical knowledge with practical application, particularly in biological and environmental sciences. Despite recognizing the value of hands-on learning, teacher training programs at the NCE level appears to remain heavily reliant on textbook instruction. This in-turns leaves future biology

teachers ill-equipped to teach practical concepts or address real-world challenges in their classrooms. A key issue is the persistence of traditional teaching methods that fail to cultivate essential skills in conservation and applied learning. Although STEM education has proven effective globally for developing problem-solving abilities, its adoption in Nigerian teacher colleges remains limited due to inadequate resources and training. Additionally, biological gardens, which could serve as valuable hands-on learning spaces seems to be underutilized, resulting in graduates who understand theory but lack practical competencies. The problem is further complicated by regional environmental challenges like soil degradation and water scarcity, as well as potential gender disparities in science engagement, none of which are sufficiently addressed in current curricula.

Existing assessment methods worsen these gaps by prioritizing theoretical knowledge over practical skills. Standardized tests fail to measure critical abilities like innovation, problem-solving, and environmental stewardship, leaving a disconnect between classroom instruction and real-world needs. This study investigates how STEM-based biological gardening can enhance both skill development and academic performance among NCE students in North-West Nigeria. The findings aim to guide reforms in teacher education, ensuring future educators are better prepared to deliver effective, practical science instruction.

Objectives of the Study

This study aims to achieve the following specific objectives:

1. Determine the effectiveness of STEM-based biological gardening in enhancing academic performance among NCE students in North-West Nigeria.
2. To assess the improvement in students' practical competencies in plant cultivation, soil management, and sustainable agricultural practices through hands-on biological gardening activities.
3. Examine gender differences in the acquisition of biological gardening skills and academic performance when STEM-based approaches are implemented.

Research Questions

To achieve the study's objectives, the following research questions were raised to guide the investigation:

1. What differences exist in academic performance between students taught using STEM-integrated biological gardening and those exposed to traditional classroom methods?
2. To what extent do hands-on biological gardening skills enhance students' competencies in plant cultivation, soil management, and other practices?
3. Are there gender-based variations in the acquisition of biological gardening skills and academic performance when STEM-based approaches are applied?

Null Hypotheses

The following null hypotheses were formulated in this study:

HO_1: There is no significant difference in academic performance between students taught using STEM-integrated biological gardening and those exposed to traditional classroom methods.

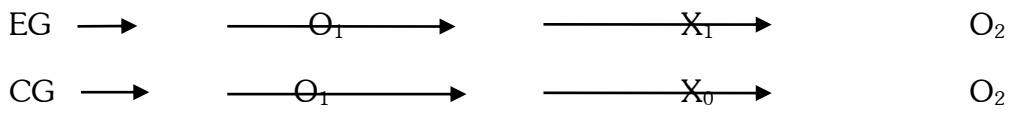
HO_2: There are no significant gender-based variations in academic performance when STEM-based approaches are applied.

METHODOLOGY

Research Design

The study employed the quasi-experimental of non-randomized pre-test-post-test, non-equivalent control group design.

Fig 1: Research Design



KEY: EG – Experimental group, O_1 – Pre-test, O_2 – Post-test, CG – Control group, X_1 – Treatment and X_0 – No Treatment.

Quasi-experimental designs are chosen because they enable researchers to study causal relationships in real-world and educational settings where randomization is impractical or unethical, while still maintaining practical relevance and strong external validity. They are cost-effective, flexible, and ethically appropriate for evaluating interventions among naturally occurring groups.

Population and Sample

The population for the study consisted of 8530 NCE two students from seven (7) Federal Colleges of Education in the northwest zone, Nigeria. The study sample comprised 135 NCE II biology students (60 males and 75 females). Simple random sampling was employed in selecting the two (2) FCEs from seven (7) using the lottery method. One class in each school was used as the experimental group and the other as the control group. One was assigned to the control group with a sample size of 63 students, while the other was assigned to the experimental group with a sample size of 72 students. One intact class was used from each school for the research purpose.

Instrumentation

One instrument was used for this study: the Biology Garden Concept Performance Test (BGCPT), which is a 25-item multiple-choice test with four options (A-D). Three of them are distractors, and the other one is the correct option. BGCPT was developed by the researcher to determine the performance of students in gardening. Scoring of BGCPT is dichotomous because of the correct and incorrect options in the alternative provided in the test. Each question attracts four (4) marks, totaling 100 marks. The items were prepared based on Bloom's taxonomy of the cognitive domain to ensure the test items cover the different cognitive levels of the students. The content validity was also established by two experts in science education from Ahmadu Bello University, Zaria. The test-re-test method was used to determine reliability with 50 students from FCE Katsina. The PPMC coefficient value of 0.78 was determined. The experimental group was exposed to gardening for six (6) weeks, and the control group was taught the same concepts for the same period without exposure to gardening. Both groups were administered a pretest before their exposure to the different methods of teaching. Then, at the end of the teaching period, a post-test was administered to both groups.

ESULTS

The study examined how STEM-based learning affects the development of biological gardening skills and enhanced academic performance among NCE students in Northwest, Nigeria. The analysis examines how teaching method (STEM-based vs. traditional method), gender, and pretest scores influenced students' posttest performance.

Table 1: Summary of Means and Standard Deviation Values for post Post-Test Scores of Experimental and Control Groups

Groups	N	Mean	SD	Mean diff
Experimental	73	28.33	5.41	
				9.35
Control	62	18.98	5.76	
Total	**135**			

From Table 1, the **experimental group had a higher average score (28.33)** compared to the **control group (18.98)**. The significance of the mean difference was tested in the related hypothesis.

Table 2: Summary of Means and Standard Deviation Values for pre- and post-rubric scores on acquisition of STEM-based biological gardening skills of the Experimental group.

Groups	N	Mean	SD	Mean diff
Pretest	73	20.8		
				29.7
Post test	73	50.5		

Table 2 revealed an improvement in the acquisition of STEM-based biological gardening skills with a mean difference of 29.7. This indicates the method enables the students to develop their skills.

Table 3: Summary of Means and Standard Deviation Posttest Scores of Males and Females in Experimental Group only.

Gender	N	Mean	SD	Mean diff
Male	32	23.57	6.81	
				0.84
Female	41	24.41	7.62	
Total	73			

From the table above, the females (Mean = 24.41) performed slightly better than the males (Mean = 23.57). However, the significance of the mean difference of 0.84 was tested in the related hypothesis.

Table 4: t test analysis of mean post test scores of students' academic performance in both groups

Groups	N	Mean	SD	df	t calc	P value	Decision
Experimental	73	28.33	5.41	133	82.56	0.000	*Significant
Control	62	18.98	5.76				
Total	**135**						

***Significant @ p≤0.05**

The table shows a statistically significant difference in post-test academic performance between the experimental (mean = 28.33) and control (mean = 18.98) groups, with a t-calculated value of 82.56 and a p-value of 0.000, which is less than the significance level of 0.05. Therefore, the null hypothesis is rejected, indicating that the intervention had a significant positive impact on the experimental group's academic performance.

Table 5: t-test analysis of mean post-test scores of male and female students' academic performance in the experimental group only.

Gender	N	Mean	SD	df	T calc	P value	Decision
Male	32	23.57	6.81	71	7.869	0.06	Not Significant
Female	41	24.41	7.62				
Total	73						

*Not Significant @ p≤ 0.05

The results show that there is no statistically significant difference in mean post-test academic performance scores between male (mean = 23.57) and female (mean = 24.41) students in the experimental group, with a t-value of 7.869 and a p-value of 0.06, which is greater than the 0.05 significance level. Therefore, the null hypothesis is retained—there is no significant gender-based difference in academic performance in this group.

Discussion

The findings of this study provide compelling evidence that STEM-integrated biological gardening instruction can significantly enhance students' academic performance and practical skills acquisition, supporting the broader literature on garden-based learning as an effective hands-on and interdisciplinary educational approach. The substantial gain in both theoretical knowledge and applied competencies confirms the crucial role of active, experiential learning environments in science education, resonating with studies emphasizing how real-world contexts like gardening facilitate deeper engagement and skill development (Gulhan, 2023; Eugenio-Gozalbo et al., 2020).

However, while the study robustly highlights the positive impact of the intervention, the exceptionally high t-value (82.56) reported between experimental and control groups calls for cautious interpretation. Such an extreme statistic suggests a possible overestimation of effect size or methodological factors such as sample characteristics or measurement precision that may have influenced outcomes. Future research would benefit from triangulating findings with multiple measures and ensuring balanced group equivalence to strengthen internal validity, particularly given the non-randomized design employed.

The noted lack of statistically significant gender differences aligns with emerging trends that inclusive, hands-on STEM activities can mitigate traditional gender gaps in science achievement (Campbell, Kelly-Weber, & Lavallee, 2021; Thompson, 2022). This supports advocating for pedagogical strategies that contextualize learning in authentic, practical experiences to promote gender equity. Nevertheless, the marginal difference observed in favor of female students, though not significant, suggests avenues for further inquiry into subtle intersectional factors that might influence differential engagement or outcomes.

Finally, the implications for teacher education are particularly insightful. By integrating STEM principles within biological gardening, educators receive practical exposure that bridges the pervasive theory-practice divide, which is a persistent challenge in teacher preparation programs (Filgona, Sababa, & Filgona, 2016). Encouragingly, the approach champions both content mastery and pedagogical skill-building, but it also highlights the need for ongoing professional development to equip teachers with competencies for implementing such innovative outdoor and interdisciplinary curricula effectively.

In summary, this study adds to the growing recognition of garden-based STEM education as a multifaceted strategy for enriching science learning and skills acquisition while advocating

for inclusive practices that support all learners. Continued research should address methodological rigor, explore nuanced gender dynamics, and prioritize teacher capacity-building to fully realize the potential of such experiential educational models.

Conclusion

The results of this study provide compelling evidence for the effectiveness of STEM-integrated biological gardening in biology education. The approach significantly improved both academic performance and practical skills while demonstrating equitable benefits across genders. These findings support the wider adoption of experiential, interdisciplinary approaches in science teacher preparation programs, particularly in contexts where sustainable agricultural practices are crucial for community development.

Recommendations

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

1. The intervention or instructional strategy used be adopted or scaled up by the government in similar educational contexts to improve student achievement.
2. Biology Educators should continue using inclusive, hands-on approaches that engage all students regardless of gender.
3. The Federal government and educational policymakers should prioritize funding and infrastructure for practical STEM education, including school gardens.

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EFFECTS OF CONCRETE INSTRUCTIONAL METHOD ON JUNIOR SECONDARY SCHOOL STUDENTS' ACADEMIC PERFORMANCE IN BASIC SCIENCE IN EKITI STATE

BY

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Abstract

This study examined the effects of Concrete Instructional Method on Junior Secondary School Students' academic performance in Basic Science in Ekiti State. The study adopted the pre-test, post-test, control group quasi-experimental research design. One research question was raised and three hypotheses were formulated. The population of the study comprised 16,256 Public Junior Secondary School II (JSSII) students in Ekiti State, Nigeria. The sample size for the study was eighty (80) JSS II students. Multistage sampling procedure was used to select the sample. The Instrument for data collection was: Basic Science Performance Test (BSPT). The face and content validity of the instrument was ensured by the experts. Kudar Richardson-21 (K_{r-21}) method was used to establish the reliability coefficient value of 0.82. The data collected were analyzed using mean, standard deviation and t-test. The findings showed that there was no significant difference in the pre-test performance scores of students in experimental and control groups in Basic Science. Also, there is significant difference in the post test performance of students in experimental and control groups when taught Basic Science in favour of experimental group. Based on these findings, the study concludes that concrete instructional method offers potent capabilities that can enhance the teaching and learning process in basic science in Ekiti State. It was recommended that the use of concrete instructional method should be encouraged in Basic Science classes in order to have concrete experience and understanding of Basic Science concepts so as to enhance better academic performance of students.

Keywords: *Concrete Instructional Method, Conventional teaching strategy, Performance*

Introduction

The importance of science and technology in contemporary time is demonstrated by its conscious and unconscious use in our daily lives. Indeed, transportation, electrical devices, medicine and food are benefits of science and technology. Also, modern societies are literally built on science and technology. Ewesor (2015) expressed that the countries of the world are currently driven by science and technology as the instrument par excellence for nation building. This is why greater emphasis is being placed on industrial and technological development not only in Nigeria but the world over. Science and technology plays a dominant role in the development of nations in which is an instrument to create in younger ones on how to make inquiry into a problem and how to proffer permanent solution to it (Elvis, 2013). According to Rulp, (2014) that Science and Technology is the bedrock of civilization and

development and no nation can afford to ignore its impact on the modern world. Science is valued by societies because the application of scientific knowledge helps to satisfy many basic human needs and improve their living standard.

Basic science is a core subject at the Junior Secondary School (JSS) level of Education. Basic Science presents science as a unified whole in order for learners to have a holistic view of the science subjects (Seweje and Jegede, 2012). It is a subject that teachers approach with wider application in terms of its concept and objectives as an academic discipline. The knowledge of Basic science is necessary for individual to be scientifically trained in different areas of endeavor. It also helps in the development of the nation science and technology advancement. Basic Science was introduced into the Nigerian secondary schools as a panacea to some of the problems bedeviling science education especially at the Junior Secondary School level.

Basic science formerly known as Integrated Science is the first form of science taught at the Junior secondary school levels. Basic Science is considered the bedrock of all science subjects at the Senior Secondary School (SSS) level. According to Oyeniyi (2019), Basic Science is a revolutionary new introductory science curriculum developed at Princeton intended for students considering a career in science. Basic Science emphasizes scientific literacy and research oriented learning (Gunseli and Guzin, 2017). The subject encourages exploration of student's immediate environment. As a result, Basic Science teachers continue to learn along with their students. Basic Science involves the study of elementary Biology, Anatomy, earth/solar system, Ecology, Genetics, Chemistry and Physics as a single science subject in the Junior Secondary School. It offers the basic training in scientific skills required for human survival, sustainable development and societal transformation. Basic Science studies also involve bringing together traditionally separated science subjects so that students grasp a more authentic understanding of science. Thus, the subject prepares students at the upper basic level for the study of core science subjects such as Biology, Chemistry and Physics at the Senior Secondary School (SSS) level (Oludipe, 2012).

Despite the utilitarian value of Basic Science in science and technological advancement and teachers' position in the teaching and learning in order to realize the subject's objectives; the subject is still characterized with lack of concrete activities which has resulted in poor manipulation and observation skills (Adepoju, 2012). Presently, the current statistics on students' academic performance in public Junior Secondary School Certificate Examination (JSSCE) in Ekiti State showed that the teaching and learning process of Basic Science as a subject at the Junior Secondary School level is still inadequate.

Concrete learning occurs when students have ample opportunities to manipulate concrete objects to solve problem. For students who have difficult in learning science, an explicit teacher who knows how to model a specific concrete objects to solve specific Science problems is needed. Additional activities with concrete materials are essential for the transfer of acquired knowledge to procedural knowledge because concrete materials help students to construct procedural knowledge. Prior learning through concrete materials makes new learning easier and more meaningful. Teachers provide declarative knowledge which enable the students use concrete materials to transfer declarative knowledge into procedural knowledge. However, guidance is needed in order for students reach the desired outcome. The procedural analogy theory instructs how to use concrete materials to

achieve a particular goal. Aniaku (2012) opined that, the persistent low academic performance in Science was attributed to the teachers instructional strategy among others, this view corroborate with that of Popoola and Olojo (2012) that, conventional teaching techniques often make students passive, leading to under performance in Science subjects.

In spite of the possible effect of different instructional strategies of teaching Basic Science, learner characteristics could also affect the learning outcome of student in Basic Science as supported by researchers such as Ochu and Haruna, (2014) and Oyeniyi, (2019). The present study is also interested in investigating how a learner could be empowered to improve on his performance in Basic Science, it is most likely that variables such as students' attitude and gender can be another factor that can affect learning outcomes in the subject.

Statement of the Problem

Despite the central role of Basic Science in building solid foundation to science education and technological advancement and various efforts by the stakeholders to improve the teaching and learning of Basic Science subject in Junior Secondary Schools, little success has been achieved. The researcher observed that the science education system in Nigeria seems to have been plagued with a lot of problems and one of the most serious problems is continuous performance of students in Basic Science that is not encouraging which is evident over the years.

Furthermore, the researcher observed that Basic Science teachers seem not to be mindful of their learning method and practice of teaching the subjects during the classroom interaction such that many of them still stick to the traditional chalk and talk method, may be due to their familiarity with it, while few occasionally use demonstration method which makes the subject looks complex and students seem to view Basic Science concepts as very difficult to understand through these methods, thereby resulting to low enrollment of students in Basic Science subject and loss of interest in offering science subjects at the Senior Secondary School level.

It has also been observed by the researcher that most teachers find it difficult to use concrete object to teach practically oriented topics in Basic Science which makes the subject to be on abstract to the students. This might be why some students lost their interest in the subject which could also affect their attitude towards the subject.

Purpose of the Study

The purpose of this study was to investigate the effect of Concrete Instructional Method on Junior Secondary School Students' academic performance in basic science in Ekiti State: This study specifically examined:

i. the effects of Concrete Instructional Method on Junior Secondary School Students' Performance in Basic Science in Ekiti State;
ii. the significant difference in the pre-test Performance scores of the experimental and control groups.
iii. the significant difference between the post-test Performance scores of students in experimental and control groups.

Research Questions

A research question was raised to direct this study.

1. What is the performance of students in Basic Science before and after the treatment?

Research Hypotheses

The following null hypotheses were postulated for this study:

1. There is no significant difference in the pre-test performance scores of the experimental and control groups.
2. There is no significant difference between the post-test performance

scores of students in experimental and control groups.

Methodology

The study adopted pre-test and post-test control group quasi-experimental research design. The design provided an opportunity to determine how the independent variables was influenced the dependent variables in the study to determine the effectiveness of the treatment. The schematized diagram for the crossing of the independent variables with the moderator variables is also expressed as follow.

Group	Pretest	Treatment	Posttest
E	O_1	X_1	O_2
C	O_3	---	O_4

Where:
E = Experimental group
C = Control group
O_1 and O_3 = Pre-test Observations
O_2 and O_4 = Post-test Observations
X_1=Treatment for Experimental group (Concrete Instructional Method)
--- = No treatment for control group (Conventional Method of Teaching)

Population

The population of the study comprised all 16,256 Public Junior Secondary School ll (JSSll) students in Ekiti State, Nigeria (Source: Ekiti State Teaching Service Commission, 2019). Junior Secondary School II (JSSll) students were considered relevant because they were not involved in Junior Secondary School Certificate Examination (JSSCE) and therefore were readily available for the study. Besides, they had been exposed to the rudiment of Basic Science concepts which facilitated their content knowledge of practical skills in Basic Science.

Sample and Sampling Technique

The sample for this study consisted of 80 students from two intact classes of Junior Secondary School II (JSS II) in Ekiti State. Multistage sampling procedure was used to select the sample. Stage one involved the selection of one out of the three senatorial districts in Ekiti State using simple random sampling technique. Stage two involved the selection of two Local Government Areas from the senatorial district earlier selected using simple random sampling technique. The third stage involved the use of simple random sampling technique to select one Junior Secondary School each from the Local Government Areas previously selected from the State. Stage Four involved the selection of students from each of the two schools earlier selected using intact classes.

Research Instrument

The study made use of one instrument, namely: Basic Science Performance (BSPT) The BSPT consisted of 24 items with four options labeled A- D that covered two major topics taught in the class i.e; Types of Energy and Thermal Energy. The correct option taken from A – D.

Validity of the Instrument

The face and content validity of the instrument was ensured by giving them to experts in Basic Science Education, Test and Measurement in the Faculty of Education, Ekiti State University, Ado-Ekiti. Their suggestions, criticism, corrections and opinions were built into the final draft of the instrument to ensure the suitability.

The final Draft of the instrument was used for data collection.

Reliability of the Instruments

To establish the reliability of BSPT, it was administered on 20 students outside the sampled area. The Data collected were analyzed using Kudar Richardson-21 (K_{r-21}) method to establish the reliability coefficient value of 0.82.The coefficient was high enough to declare the instrument reliable.

Experimental Procedure

The experimental procedure was carried out in eight weeks as follows, which include the pre treatment stage, treatment stage and post treatment stage.

Pre-treatment Stage (One Week)

At the pre-treatment stage, the researcher visited the selected schools with a letter of introduction to obtain permission from the principals and the Basic Science teachers to use their schools and students. This was followed by discussion with Basic Science teachers to intimate them with the purpose and the objectives of the research. The researcher thereafter took time during the week to train the research assistants for the experimental group on the proper use of the instrument and the teachers guide. The Basic Science Performance Test (BSPT) was administered on the two groups to obtain the pre-test scores.

Treatment stage (Six Weeks)

At this stage, the researcher handed over the instructional materials and teaching manual she developed to the research assistants which they used as guide to teach the selected topics for the study. The students in experimental group were exposed to the use of concrete instructional method of teaching while the students in the control group were taught using the conventional method in the same period at their respective schools.

Post-treatment Stage: One week

At the post-treatment stage, the BSPT was administered to the students, so as to determine their level of performance after the whole exercise. The scores obtained constituted the post-test scores for the study. Thus the experimental procedure lasted for eight weeks.

Data Analysis

The data obtained were analyzed using appropriate descriptive and inferential statistics. Specifically, the mean, standard deviation, and bar-charts were used to answer the research question while t-test was used to analyze all the hypotheses generated. All the hypotheses were tested at 0.05 level of significance.

Results

Question 1: What is the performance of students in Basic Science before and after the treatments?

In answering the question, performance of students exposed to concrete instructional and conventional methods of teaching Basic Science before and after treatment were computed and compared.

Table 1: Mean and Standard Deviation of Students in Experimental and Control groups before and after treatment.

Group	*N*	*Pretest*		*Posttest*		*Mean Difference*
		$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	
Control	40	13.270	1.275	15.170	1.408	1.90
Concrete Instructional Method	40	14.700	5.491	18.070	8.137	3.37

Table 1 showed that, students in the control and experimental groups had mean scores of 13.27 and 14.70 respectively prior to treatment, which appeared to be closer prior treatment. On exposure to treatment, students taught with concrete instructional method had the higher mean score of 18.07 while the students in the control group had the least mean score of 15.17. This implied that, the use of concrete instructional method was more effective than conventional method in enhancing the performance of students in Basic Science.

Testing of Hypotheses

Hypothesis 1: There is no significant difference in the pre-test scores of students in experimental and control groups in Basic Science.

The pre-test scores of students in experimental group and those in the control group were computed and compared for statistical significance using t-test at 0.05 level. The result is as presented in Table 2.

Table 2: t-test of pre-test scores of students in experimental and control groups

Group	*N*	x	*Sd*	*df*	*t*	*P*
Control	40	13.27	1.28	78	0.26	0.76
Experimental	40	14.70	5.49			

p>0.05 (Not Significant)

The result in Table 2 showed that t= 0.26, p = 0.76> 0.05. Since the p-*value* is greater than 0.05, hence, the null hypothesis was not rejected. This implied that there was no significant difference in the pre-test scores of students in experimental and control groups. This showed that the two groups were homogeneous at the commencement of the experiment.

Hypothesis 2: There is no significant difference in the post test science of students in experimental and control groups when taught Basic Science.

The post-test scores of students in experimental group and those in the control group were computed and compared for statistical significance using t-test at 0.05 level. The result is presented in Table 3.

Table 3: t-test of post-test of students in experimental and control groups

Group	*N*	$\bar{x}$	*Sd*	*df*	*t*	*p*
Control	40	15.17	1.41	78	7.76	0.00*
Experimental	40	18.07	8.14			

*$p<0.05$ (Significant result)

The result in Table 3 showed that t= 7.76, p = 0.00 < 0.05. Since the p-v*alue* is less than 0.05, the hypothesis was rejected. This implied that, there was a significant difference in the post-test scores of students in experimental and control groups. The performance the students in the experimental group performed better than those in the control group. Hence, the concrete instructional method was effective than the conventional method.

Discussion

The study's result indicated that both the experimental and control groups had a similar low performance levels before the intervention of the treatment. This suggested that both groups had an equivalent knowledge base before the experiment was applied. This indicated that, the two groups were homogenius initially. Therefore any notable difference observed later could be attributed to the specific interventions applied. It was recorded that, both groups mean scores were low, the researcher believes that, this might be linked to the use of traditional method of teaching in Basic Science which might not be effective enough and might not sufficiently address the students learning challenges in Basic Science. This aligned with the view of Aniaku (2012) that, the persistent low academic performance in Science was attributed to the teachers instructional strategy among others, this view corroborate with that of Popoola and Olojo (2012) that, conventional teaching techniques often make students passive, leading to under performance in Science subjects.

The findings of the study also revealed that, there was a significant difference in the performance score between the experimental and control groups after the treatment was applied. This suggested that, concrete instructional method was more effective in improving students performance in Basic Science than the conventional method of teaching, This aligns with Oyeniyi (2019) that, concrete instruction accelerates learning and grant students more agency in their educational experience. Awodun (2016) indicated that, concrete instructions enhances teaching effectiveness and subsequently improve students' learning outcomes.

Another observation from the study was that, there was no difference in the pre-test mean scores of students in the experimental and control groups before the implementation of the treatment. The result indicated that, both the experimental and control groups had low pre-test means scores, which indicated that, both groups were comparable in terms of their attitude towards Basic Science before the treatment.

The research revealed in the data collected that, students who were taught using concrete instructional method achieved a higher mean scores in their post-test after being exposed to treatment compared to those educated using conventional method, this means that, the notable difference between the two groups was as a result of the treatment. This suggested that, implementing concrete instructional method in teaching the students influenced the students' attitude towards Basic Science. The researcher believed that, concrete instructional method help students to grasp Basic Science concepts more effectively leading to a significant shift in the students attitude

towards the subject compared to conventional method of teaching. This observation aligned with that of Gunseli and Guzin (2017) assertion that, a positive attitude toward Science significantly correlates with students' performance in the field. The use of concrete instructional method can transform students attitude, shifting them from passive to achieve learners, Jegede (2016) revealed that, effective teaching method can foster positive behavioral changes in learners.

Conclusion

Based on the findings of this study, it was concluded that, concrete instructional method offers a potent capabilities that can enhance the teaching and learning process, which can benefit both the students and educators in Nigeria.

Recommendations

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

1. The use of concrete instructional method should be encouraged in Basic Science classes in order to have concrete experience and understanding of Basic Science concepts so as to enhance better academic performance of students.
2. The conventional method of teaching which is only teacher's centered should be enhanced.
3. Seminars, Workshops, In service trainings and symposiums should be organized from time to time for Basic Science teachers in order to update and broaden their knowledge and scope in the use of concrete instructional method of teaching.

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REVOLUTIONIZING INDUSTRIAL WORKFORCE THROUGH TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING (TVET) IN NIGERIA

BY

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ABSTRACT

This paper examines the potential of Technical and Vocational Education and Training (TVET) to revolutionize the industrial workforce in Nigeria. It explores the concept of TVET and analyzes its future impact on transforming Nigeria's workforce. The study is based on a bibliographical review of journals, textbooks, and online materials, focusing on the role of TVET in developed countries and how similar approaches can address Nigeria's economic challenges. By fostering positive attitudes toward work among the nation's youth and integrating career education across all educational levels, TVET can develop a skilled and productive workforce. The findings indicate that revolutionizing Nigeria's workforce through TVET will lead to advancements in modern technology, economic growth, improved educational standards, and enhanced living conditions, alongside increased employment opportunities.

Keywords: *Technical and Vocational Education and Training, Workforce Revolution, Globalization, Employment*

Introduction

Technical and Vocational Education and Training (TVET) provides individuals with the knowledge and skills necessary for employment through formal, non-formal, and informal learning methods. TVET is widely recognized as a critical tool for promoting social equity, inclusion, and sustainable development. It plays a significant role in equipping and empowering young people by developing their knowledge, dexterity, and practical skills, similar to indigenous education systems. Institutions offering TVET include polytechnics, monotechnics, and innovation enterprise institutions, among others.

Globally, the importance of TVET in developing the industrial workforce is well acknowledged, particularly in developed countries such as the USA, Canada, China, and Singapore. TVET programs are designed to provide individuals with the skills needed to establish and operate small or large-scale industries. These programs facilitate the acquisition of practical and applied skills alongside basic scientific knowledge. TVET is a planned sequence of courses and learning experiences that begin with career exploration, support foundational academic and life skills, and enable achievement of high academic standards, leadership qualities, industry readiness, and opportunities for advanced and continuing education (CTE, 2009).

In Nigeria, TVET is embedded in the National Policy on Education (NPE, 2004) and guided by the National Board for Technical Education (NBTE, 2011), focusing on quality technological human resource development aimed at creating a skilled, self-reliant workforce of craftsmen, technicians, and technologists in technical and vocational fields. As Osogwa and Diogu (2007) assert, there

is an urgent need to redirect public attention toward self-reliant and sustainable livelihoods through technical education.

Concept of Revolutionizing and Technical and Vocational Education and Training (TVET)

Revolutionizing refers to making a major transformative change, similar to the 1990s internet revolution that drastically altered communication, information access, and work practices. When something revolutionizes an activity, it brings significant improvements or shifts in how that activity is performed. TVET is a type of education focused on preparing a skilled workforce to support sustainable national development through the provision of employable skills, poverty reduction, and the application of scientific and technological knowledge to enhance national productivity (Obadara and Oyebolu, 2013). According to Okoye and Okwelle (2013), TVET emphasizes a pragmatic attitude for both individual and community development. They describe TVET as fostering the development of the "3Hs": the head (knowledge), the hand (dexterity), and the heart (conscientiousness and perseverance). Umar (2016) adds that TVET aims to address critical issues such as poverty and unemployment.

Training, as defined by Onalu (2011), involves teaching specific skills or behaviors through consistent practice and instruction to perform a job. Okoye and Okwelle (2013) view TVET as a broad and diversified educational system that significantly contributes to economic growth by producing sustainable manpower aligned with the needs of industries, society, and evolving technological environments. TVET develops the knowledge, skills, and attitudes necessary to perform specific tasks in the workplace. Ekpenyong (2011) explains TVET as the study, mastery, and application of manufacturing and industrial methods, as well as the systematic use of knowledge for practical industrial tasks. Similarly, CTE (2009) describes TVET as a program designed to equip individuals with skills needed to establish and run small or large-scale industries.

Key features of TVET include competency-based skill acquisition and a foundation in sound scientific knowledge. It focuses on developing a pool of skilled, self-reliant craftsmen, technicians, and technologists who act as initiators, facilitators, and implementers of a nation's technological progress. Based on these definitions, it is evident that technical education is vital for training personnel who will drive technological development and foster technological literacy among youth. However, TVET faces significant challenges such as inadequate funding, poor facilities, and qualitative and quantitative constraints, which will be further discussed in this paper.

Challenges Facing the Implementation of TVET

The challenges confronting the implementation of the TVET curriculum in Nigerian educational institutions largely mirror the broader problems facing both TVET and the general education system in Nigeria. Egwu (2009) identified several key challenges within the Nigerian university system that affect TVET implementation:

i. **Institutional Challenges:** These include unstable academic calendars, weak collaboration between tertiary institutions and the organized private sector, inadequate and outdated infrastructure and equipment (such as poorly equipped workshops and libraries), dilapidated classrooms, and insufficient support for programs like the Student Industrial Work Experience Scheme (SIWES).
ii. **Human Resource Challenges:** The sector suffers from brain drain, staff shortages, unattractive working conditions for teachers, and a general flight of skilled human capital.

iii. **Government-Related Challenges:** Chronic underfunding of tertiary institutions hampers the growth and quality of TVET programs.
iv. **Student-Related Challenges:** Issues such as cultism, examination malpractice, and other social and academic vices further undermine the effective implementation of TVET (Egwu, 2009).

Funding is widely regarded as the most critical challenge. Udoka (2010) and Yusuf and Soyemi (2012) emphasize that inadequate financing is a major barrier to the successful delivery of the TVET curriculum. Okoroafor (2010) further highlights specific problems, including:

- **Lack of Sponsorship:** Educational managers often struggle to sponsor TVET lecturers to attend seminars, conferences, and short courses due to limited funds, hindering lecturers' professional development.
- **Inadequate Infrastructure:** Without proper facilities, TVET lecturers cannot effectively translate theoretical knowledge into practice.
- **Insufficient Time for Upgrading Skills:** Heavy workloads prevent TVET lecturers from engaging in research and skill enhancement activities.
- **Lack of Recognition and Rewards:** There is often no system to reward excellence among TVET practitioners.

Other scholars, including Nwogu and Nwanoruo (2011), Olaitan (1994) as cited in Odu (2011), and Okebukola (2012), echo these concerns, citing inadequate human and material resources (both in quality and quantity), poor funding, infrastructural deficiencies, substandard lesson preparation by teachers, and social vices as additional obstacles. Mohammed (2005), cited in Ayonmike (2013), points to low teacher motivation as a significant problem, largely caused by the low esteem in which TVET teachers are held. Onjewu (n.d.) adds that insufficient funding also affects the provision of teaching aids, furniture, laboratories, workshops, and basic infrastructure such as classrooms and seating arrangements. For example, architecture students often share tables due to inadequate facilities, which is particularly problematic given the technical nature of their courses.

Ekpenyong (2011), as referenced by Ayonmike (2013), identifies multiple factors that have impeded the smooth implementation of TVET's goals. The National Board for Technical Education (NBTE, 2011) highlights critical sector challenges, including:

- Low societal recognition of TVET, leading to poor enrollment and an insufficient skilled workforce.
- Obsolete instructional facilities.
- Inadequate funding and staffing.
- Weak linkages between TVET institutions and industry.
- Overall quality deficiencies.

Moreover, the evaluation methods across all education sectors rely heavily on conventional examinations, which often fail to adequately assess practical skills essential for industry readiness.

Revolutionizing Industrial Workforce Through TVET

The application of Technical and Vocational Education and Training (TVET) in the country's education sector will revolutionize the workforce, improving it in several key areas such as:

i. Curriculum Modification

Curriculum modification involves making changes to existing modules or programs at both undergraduate and postgraduate levels. To establish and effectively manage TVET, it is crucial to revisit the existing system to enhance the overall TVET ecosystem. This includes improvements in governance and management, teacher training, curriculum design and pedagogy, collaboration with social partners, and fostering innovation through both private and public sector engagement. This paper has previously discussed some of the challenges Nigeria faces in reforming TVET for the world of work. Furthermore, it covers strategic planning and

recommendations that could benefit Nigeria's TVET development.

For example, mathematics and science have been incorporated into the new curriculum, distinguishing it from the old one. This modified curriculum aims to realize the national goal of building a united, strong, and self-reliant nation, as outlined in the National Policy on Education (NPE, 2004). TVET is used as a tool to develop individuals with appropriate skills and to nurture mental, physical, and social abilities and competencies, equipping individuals to live effectively and contribute to societal development. The curriculum is expected to bring noticeable changes by fostering the acquisition of the right skills, attitudes, competences, as well as critical, creative, and reflective thinking. Indeed, Onopounu (2016) considered TVET indispensable for empowering citizens of any nation. Curriculum modifications are designed to enable Technical College graduates to secure employment either upon completing the entire course or after finishing one or more modules of employee skills, set up their own businesses, become self-employed, and employ others.

ii. Mode of Training:

The quality of output from teachers in colleges has recently been poor, which may be attributed to ineffective quality assurance measures within these institutions. Instruction and training must emphasize core values, and promote physical, emotional, and psychological development alongside acquiring competencies necessary for self-reliance. Hence, the curriculum outlines a training pattern that includes general education, theory and related courses, workshop practice, industrial training/production work, and entrepreneurial training. This holistic approach is intended to increase the workforce's technical knowledge and enhance the application of appropriate technical measures within individual and subsector activities.

However, poor implementation of the curriculum remains common. Infrastructure and physical facilities are inadequate and often deteriorating, which fails to motivate students to acquire practical skills. Therefore, effective participation in skill acquisition development programs requires maintaining a teacher-to-student ratio of 1:20 (NPE, 2014). This ratio should become a focus for TVET as it relates to the labor market, specifically the supply side, i.e., the supply of workers.

Inadequacies in teaching, laboratory, and workshop facilities have significantly contributed to the decline in the quality of technical education graduates. Uwaifo (2005) lamented that only a small proportion of students benefit from the current system used in technical and vocational education.

Virtual Reality: A Tool for Improving the Teaching and Learning of Technology Education

Uwaifo (2005) further noted that due to inadequacy of instructional facilities, only a few students benefit from the pedagogical systems currently used in developing countries like Nigeria, especially in technical and vocational education. The unavailability of facilities has led to ineffective teaching and learning methods. Therefore, it is highly recommended that TVET employ the European Training Foundation (ETF) system to revolutionize TVET. The ETF approach prioritizes continuous improvement of core quality assurance measures related to context, input, process, output, and outcome standards. It takes into account emerging needs driven by changing economies and labor markets, the growing need to support lifelong learning, and the internationalization of TVET, which may require renewed quality assurance approaches (Elizabeth Watters and European Training Foundation, 2015).

Moreover, the ETF defines quality assurance as composite measures established to verify that processes and procedures are in place, ensuring the quality and continual improvement of TVET, thereby bringing

about its revolutionization. This revolutionizing is achievable because the ETF aims to guide quality assurance in TVET policies and approaches so that they:

- Are fit for purpose and context, emphasizing relevance and cost-effectiveness;
- Acknowledge that quality assurance is a dependent variable influenced by context and other VET policy themes;
- Address VET inputs, processes, outputs, and outcomes;
- Apply the quality cycle: plan, implement, monitor and evaluate, review, and renew;
- Make visible strengths, weaknesses, and improvements;
- Promote quality improvement through a pervasive quality culture;
- Take into account internationally accepted quality assurance concepts and European policies and models.

The ETF promotes quality assurance policies and approaches that ensure VET:

- Responds to labor market needs;
- Leads to nationally or internationally recognized qualifications or credentials;
- Provides access to decent jobs and sustainable employment;
- Is inclusive and accessible, allowing all citizens access to TVET and fostering capabilities that enable progression to further learning (Elizabeth Watters and European Training Foundation, 2015).

According to the Organisation for Economic Co-operation and Development (2005), ICT facilities for student training are limited. Affordable and reliable internet connectivity is only available in a few institutions, faculties, and offices. Additionally, power fluctuations and deficient bandwidth have considerably reduced the reliability of access, making technological integration difficult.

Admission Requirement: In Nigeria, the basic minimum admission requirement for TVET is the Junior Secondary School (J.S.S) 3 result, although students who have attempted Senior Secondary School are generally more eligible. This policy aims to attract more youths into the program and reduce dropout rates. The admission process is publicized through jingles on radio, television, print media, and other channels to raise awareness about the program. Admission forms are sold along with information about the dates for entrance examinations and interviews. Candidates who meet the cutoff marks (successful candidates) are issued admission letters and given instructions on when to resume studies. According to Mar (2009) and Adawo, the nation's economy largely depends on the performance of such programs. In other countries, admission requirements may include age (usually 16, considered adulthood in many foreign countries) and no formal education prerequisite, but candidates must possess essential skills such as analytical and non-cognitive abilities—critical thinking, problem-solving, creativity and innovation, collaboration, communication, entrepreneurship, as well as tolerance, ethics, flexibility, and a positive attitude. These skills are necessary to produce not only competent workers but also individuals with the right attitudes. Salleh, Sulaiman, and Gloeckner (2015) define competency as the ability to perform tasks combining knowledge, skills, and attitudes. Similarly, the Organisation for Economic Co-operation and Development (OECD, 2005) defines competency as a worker's capability to apply skills in specific contexts.

Prospects and Benefits of TVET to the Nigerian Workforce: It is essential to understand the prospects and benefits that Nigeria can derive from TVET in revolutionizing its workforce, both academically and in manufacturing. Mertineit (2013) highlights that TVET plays a central role in developing and implementing sustainable development, especially in green economies. The benefits and prospects of Technical and Vocational Education and Training (TVET) include significant contributions

to economic development, as noted by Kwami, Yaduma, and Onuh (2014). One key benefit of TVET is economic development, achieved when individuals are gainfully employed and also become employers of labor, contributing to national growth.

Entrepreneurship, as defined by Ugiagbe and Umunna (2002), is the process of combining innovative and creative ideas with appropriate management strategies to mobilize resources to meet needs and create wealth. Entrepreneurship enhances self-employment (Fenemigbo, 2008), which is a vital aspect of revolutionizing TVET.

Employment Creation: According to the International Labour Organization (2010) and Inyiagu (2014), TVET is a skill-based approach that prepares workers for various occupations and trades. It promotes highly skilled workers, both men and women, who can enter the job market early and support themselves with decent, sustainable work and wealth creation. Tiong (2002) concurs that TVET prepares recipients for employment by exposing them to job-specific and employability skills, giving them a foundation in business environment functions. He further states that business naturally grows from technical and vocational skills, producing graduates who are not only gainfully employed but also become business owners and employers of labor. UNESCO-UNEVOC (2016), an international TVET center, defines TVET as "the acquisition of knowledge and skills for the world of work."

Skills Acquisition and Development: The Partnership for 21st Century Skills (2008) emphasizes TVET's role in human resource development as a determinant of growth industries and job opportunities globally, elevating TVET's significance worldwide. Enahoro (2008) argues that because individuals have diverse natural gifts and talents, TVET should train people for the broad range of opportunities available.

Ekpenyong (2008) identifies the broad areas of TVET as follows:

1. Technical Education
   a) Engineering Technology and related subfields
   b) Electrical/Electronic Technology and related subfields
   c) Building Technology and related subfields
   d) Automobile Engineering and related subfields
2. Business Education
   a) Office/Secretarial Studies/Office Technology Management
   b) Accounting Studies
   c) Distributive or Marketing Studies
   d) General Business Studies
3. Agricultural Education
   a) Agronomy
   b) Soil Science
   c) Agricultural Engineering
4. Home Economics
   a) Home Science
   b) Food Science
   c) Clothing and Textiles
   d) Hotel and Catering Management

If these broad areas are adequately addressed, they can propel the nation toward growth and development. These sectors can reduce poverty and unemployment by developing the skills and knowledge of the workforce in various industries, achieving high added value and economic prosperity, ultimately improving the standard of living for all individuals.

Increased Production and Service Capacity Improvement: UNESCO (2003) notes that effective use of technology increases production and service capacity in society, thus reducing the need for importation and boosting exports of brainpower, goods, and services that bring honor and prosperity to the nation.

Improved Standard of Living: Mertineit (2013) states that TVET plays a central role in sustainable development, which improves the standard of living in any society. TVET helps develop workers' knowledge and skills, empowering them with not only technical competencies but also entrepreneurial mindsets and thinking skills linked to sustainable

development, access to further education, and job creation. It also empowers individuals to become employers of labor and achieve financial freedom. Sustainable development involves economic, social, and environmental progress, and TVET is significant in this respect. Through job creation, TVET can drastically improve people's living standards, serving as a blessing to society.

Intellectual Development: According to the Asian Development Bank (2015), quality skills, access to education, and occupational profiles are critical trends in TVET. Intellectual development is enhanced when institutions introduce non-conventional courses using Massive Open Online Courses (MOOCs), blended or hybrid learning, online platforms, and similar technologies. These platforms support personal and professional development through short courses, upskilling, workforce training, and lifelong learning offered by TVET institutions, thus increasing human knowledge and development.

Increased Student Interest in TVET: Student interest in TVET can be significantly increased by employing the Production-Based Learning (PBL) model. This model creates an environment where students are encouraged to be more creative, adventurous, and to engage in critical thinking about their activities. It also provides scientific and financial value, which helps students gain acceptance in society. The PBL model enhances students' experiences and deepens their understanding and competencies in areas such as entrepreneurial skills, cognitive, affective, and psychomotor domains. Ultimately, this approach helps produce a revolutionized and skilled workforce.

Funding: Revolutionizing TVET is unattainable without adequate funding, which is essential across all areas of TVET. The Education Trust Fund (ETF), a government agency, was established to provide funding for innovative and technology-based research due to the general scarcity of funds for specialized education (Gabadeen & Raimi, 2012; Idris et al., 2012). However, the government's education budget is divided among several agencies and parastatals, including the Ministry of Education, universities, polytechnics, colleges of education, government colleges, and technical schools. This fragmented allocation has proven ineffective. Therefore, a separate and dedicated budget for TVET should be considered to address the hindered circulation of funds.

The current distribution of funds contradicts the effective utilization of limited resources. Learning from China's successful TVET funding model could provide useful insights for Nigeria. TVET policymakers in Nigeria must study and adapt key elements of China's funding policies, which have allowed China to successfully navigate global trends and develop a robust TVET system. Despite interventions by ETF and TETFUND, funding for TVET in Nigeria remains insufficient and inadequate (Ladipo, Akhuemonkhan, & Raimi, 2013).

Monitoring Strategies: According to the Ethiopia Ministry of Education (2008), monitoring strategies are crucial for revolutionizing the workforce. The TVET executive bodies, together with their stakeholders, should establish a monitoring system that translates strategic objectives into measurable indicators and identifies ways to verify these indicators. The system must align with national development indicators and ensure relevant information is collected by appropriate bodies. If necessary, baseline studies should be commissioned and data updates overseen regularly. The TVET executive bodies should compile the monitoring results into an annual TVET Progress Report that is submitted and published to track advancement. If Nigeria adopts similar monitoring strategies, institutionalizing an effective TVET workforce system will be achievable.

Summary

This paper has examined the impact of Technical and Vocational Education and Training (TVET) in developed countries and explored how Nigeria can address its economic challenges by improving its workforce. The development of a positive attitude toward TVET and the creation of a conducive environment for youths will help produce a skilled and productive workforce. The study highlights the benefits of TVET for Nigeria, emphasizing that revolutionizing the workforce through TVET will drive improvements in modern technology adoption, boost the nation's economic and educational standards, improve living conditions, and increase employment rates.

Conclusion

In conclusion, modern technologies such as ICT, advanced equipment, and new methods of doing things are best adapted through technical and vocational education. To meet the demands of the new economy, Nigeria must improve its workforce by providing technical and vocational education and retraining across all levels of education. This will revolutionize the workforce, improve living standards, raise employment, and make the country economically resilient and viable. It is crucial to face the realities and challenges of development through TVET; otherwise, Nigeria risks remaining backward, continuing as a consumer rather than a producer, and subject to new forms of colonial influence.

Recommendations

To effectively revolutionize Nigeria's workforce through TVET and meet global demands, the following recommendations are made:

i. Government and educational stakeholders must recognize TVET as vital to national development and its role in producing labor-market-ready graduates that contribute to economic growth.
ii. The government should allocate a separate budget for TVET annually to ensure adequate funding for tools, equipment, infrastructure, instructional facilities, and welfare packages for teachers and students.
iii. Technical education should be introduced and promoted from the primary level, with particular emphasis on ages 14–16 for a significant portion of pupils, followed by widespread vocational education for those 16 and above, to help youth master skills and professionalism.
iv. The Education Trust Fund (ETF) allocation for TVET should be increased, complemented by funding from international organizations (e.g., UNDP, UNESCO, DFID, ADB, World Bank) and local groups (PTAs, churches, NGOs, philanthropists), recognizing that TVET is capital intensive.
v. Effective monitoring strategies should be implemented by bodies like the National Board for Technical Education (NBTE) to oversee TVET activities in technical colleges, colleges of education, polytechnics, and universities.
vi. Barriers to progression in employment should be removed, and a comprehensive national technical/vocational qualification framework should be developed to improve the quality and socio-economic status of skilled technical workers, expanding the role of NABTEB.
vii. Continuous training, retraining, and welfare support for TVET teachers should be prioritized to reduce teacher attrition and maintain quality instruction. Research units should be established to innovate and improve curriculum delivery for effective workforce preparation.
viii. The TVET system in Nigeria must be realigned to meet the evolving requirements of the

economy and the workforce effectively.

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ASSESSING GENDER DIFFERENCES IN NANOTECHNOLOGY AWARENESS, EXPOSURE AND MOTIVATION AMONG PHYSICS UNDERGRADUATES IN OYO STATE

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Abstract

Advances in nanotechnology have drawn attention to nanotechnology education. The study assessed gender differences in nanotechnology awareness, exposure and motivation among physics undergraduates. The study was guided by three hypotheses. The population of this study comprises all undergraduate physics students of Ekiti State university affiliated with Emmanuel Alayande College of Education, Oyo, during 2022/2023 academics session. Data was collected using a questionnaire titled Nano-Awareness, Exposure, and Motivation Questionnaire (NAEMQ) and presented using frequency counts, simple percentage, mean and chi-square. The findings of the study reveal that: the participants have good awareness of, exposure to, and motivation for nanotechnology and the level of awareness of, exposure to, and motivation for nanotechnology was dependent on genders of respondents. Based on the results of findings, it is recommended that physics education programs should capitalize on the existing awareness, exposure, and motivation of undergraduate students towards nanotechnology, and enhance their curriculum to include more nanotechnology-related content, particularly in areas where gender disparities were identified.

Keywords: Physics Students, Nanotechnology, Awareness, Exposure, Motivation and Gender

Introduction

Nanotechnology is one of the most important technologies of our time and has become one of the most important fields in the field of science because of its profound impact in various aspects including environmental sustainability, which is to be based on the activation of nanotechnology in our scientific and practical public life as well as the preservation of the environment (Boras et al., 2018). The concept of nanotechnology has become linked to the development of the educational system as it is a contemporary type of technology, which is based on the integration of many disciplines that must be integrated into the educational system and take advantage of its applications (Alqahtani, 2020). Nanotechnology is a broad applied area as it directly and indirectly enters all

human needs and scientific and environmental developments (Ayad, 2017). Economists have estimated that nanotechnology will accomplish development aims in diverse fields by 2025 as an emergent technology and new industrial revolution, leaving its mark on the 21st century (Roco et al., 2011).

It is therefore essential that students be aware of this field of technology to keep up with the developments as it has become a requirement to meet the challenges of the times (Darwish & Abu , 2018). Yawson (2012) argued that nano consciences need to be integrated into curricula for students to become more aware of, and have a better understanding of nanotechnology, i.e. there is an urgent need for them to be aware of developments and developments related to nanotechnology and its effects on environmental sustainability and the so-called "nanoring" or "nano-enlightenment'' (Yawson,2012). Adegboyega et al (2023) studied determinants of awareness levels of Physics teachers about nanoscience and nanotechnology (NSNT) in senior secondary schools and concluded that majority of the participants have awareness about nanoscience and nanotechnology and the level of awareness of the physics teachers was independent of their genders.

Although modern nanotechnology is well-established, the current generation of science teachers typically has little exposure to nanoscience and nanotechnology (NSNT), and few opportunities to understand the basic concepts of NSNT (Pas et al., 2019). Therefore, undergraduates will experience a maximal NSNT exposure, with risks in learning abstract and complex NSNT concepts, thus necessitating an improved introduction to NSNT. Ekli & Şahin (2010) emphasized conveying advantages of NSNT to undergraduates, and other authors have maintained that NSNT education may start early at pre-school level, continuing to undergraduate education (Alpat et al., 2017; Roco & Bainbridge, 2005; Sagun-Gıkıız & Akaygьn, 2013). Furthermore, exposure to science develops positive attitudes, which can be pursued and further developed in a formal way (Ban & Kocijancic, 2011; Alpat et al., 2017; Saidi & Sigauke, 2017; Andina et al., 2019), contribute to analytical thinking (Winkelmann & Bhushan, 2016) and produce next generation scientists and researchers firmly grounded in the discipline. Harthorn (2010) has noted that women are less familiar with nanotech, less enthusiastic about it, and less willing to tolerate nano-related risk. One method of increasing students' motivation to pursue nanotechnology as a field of study or career is to provide opportunities for awareness and exposure to it (nanotechnology). Because of the growing demand for nanotechnology experts, it is clear that many students are needed. In order to satisfy the pipeline requirements for a trained workforce, it is critical to determine if the programs or courses put in place have an effect on students' awareness, exposure, and motivation to study nanotechnology. In the present study, the researcher assesses gender differences in nanotechnology awareness, exposure and motivation among physics undergraduates, believing that the study would contribute towards promoting NSNT as a next generation topic for undergraduates.

Statement of the Problem

The need to raise students' awareness, exposure and motivation about Nanotechnology (NT) has been assessed in a variety of studies. Ban & Kocijancic (2011) highlighted the need to integrate nanotechnology into educational system to enhance students' motivation and interest. Khan (2016) stressed the importance of promoting students' awareness and understanding of nanotechnology to prepare them for future careers. Mammino (2012) argued

that educational programs should focus on raising student' awareness and interest in nanotechnology to address the shortage of skilled professionals in the field.

However, none of these researchers probed into the expertise of the level of awareness, exposure and motivation on Nanotechnology among physics undergraduate, particularly in relation to gender differences. Nigeria a developing country should not be left behind in the field of Nanoscience and Nanotechnology Education at the undergraduate level. The undergraduate physics students' awareness of, exposure to and motivation for Nanotechnology and its disciplinary perspective becomes highly necessary. This study aims to investigate the disparities in nanotechnology awareness, exposure and motivation between male and female undergraduate Physics student in Oyo state, there by contributing to the development of more effective strategies for promoting nanotechnology education.

Objective of the Study

The objectives of this research are to determine the:

1. influence of gender on physics undergraduates' awareness of nanotechnology;
2. influence of gender on physics undergraduates' exposure to nanotechnology;
3. influence of gender on physics undergraduates' motivation for nanotechnology;

Research Hypotheses

These hypotheses are formulated for the study.

H_{01}: Awareness level of Nanotechnology is independent of gender of respondents

H_{02}: Exposure level to Nanotechnology is independent of gender of respondents

H_{03}: Motivation level for Nanotechnology is independent of gender of respondents

Research Methodology

This study is a descriptive survey that assessed gender differences in nanotechnology awareness, exposure and motivation among physics undergraduates.

The population of the study consisted of all physics undergraduates of Ekiti State University affiliated with Emmanuel Alayande College Education, Oyo, Oyo State during the 2022/2023 academic session. The study made use of all the twenty-one (21) 100-level students comprising twelve males and nine females, all thirteen (13) 200-level students comprising six males and seven females, all twenty-three (23) 300-level students comprising fifteen males and eight females, all twenty-seven (27) 400-level students comprising fourteen males and thirteen females, making a total of eighty-four (84) respondents comprising forty-seven males and thirty-seven females.

A designed questionnaire titled Nano-Awareness, Exposure, and Motivation Questionnaire (NAEMQ) was used as instrument to collect information from the respondents. The questionnaire consisted of two parts. The first part consisted of personal and demographic information which include gender and academic level in the institution while the second part investigated physics undergraduates' awareness of, exposure to and motivation for Nanotechnology. The responses were rated on a five-point Likert- type scale. A five-point Likert scale type of strongly agree, agree, neutral, disagree, and strongly disagree was employed to obtain responses of respondent. The option assigned in numerical weight are 5,4,3,2 and 1 for strongly agree, agree, neutral, disagree, and strongly disagree respectively. The mean of the rating scale was computed and yielded (3) which was used for taking decision. Any mean below the mean of (3) was rejected while items with mean of (3) and above were accepted. Also, research hypothesis was approached

using chi-Square test of Association and independence

The Questionnaire was subjected to peer-review by professionals to ascertain its validity while Cronbach Alpha reliability method was used to ascertain the reliability of the instrument and this yielded a reliability coefficient of 0.82. The reliability of items of questionnaire examined for second part was 0.82 affirming the instrument is reliable.

Permission and approval were sought from the head of Physics department of the College of the above aforementioned institution for the personal administration of the questionnaire. The instrument was administered to the respondents personally by the researcher and he waited for immediate collection.

The data collected were analyzed using frequency counts, and simple percentages for the demographic variables while the data collected for each item in section B of the questionnaire were coded and analyzed using descriptive statistic mean.

Result and Discussion of Findings

Table 1: Physics undergraduates' awareness level of nanotechnology.

S/N	ITEMS I can:	SA	A	N	D	SD	Mean	Decision
1	Name a Nano scale-sized object.	59 (70.2%)	13 (15.5%)	9 (10.72%)	2 (2.38%)	1 (1.2%)	4.51	Accepted
2	Describe one way nanotechnology directly impacts my life.	15 (17.9%)	27 (32.14%)	27 (32.14%)	9 (10.71%)	6 (7.14%)	3.43	Accepted
3	Name a field of study that currently conducts Nanotechnology research.	38 (45.23%)	13 (15.5%)	17 (20.23%)	11 (13.1%)	5 (5.95%)	3.81	Accepted
4	Describe one-way nanotechnology may benefit Society/ humankind.	13 (15.5%)	22 (26.2%)	13 (15.5%)	24 (28.6%)	12 (14.28%)	3.00	Accepted
5	Name an application of nanotechnology.	36 (42.9%)	13 (15.5%)	14 (16.6%)	12 (14.3%)	9 (10.7%)	3.65	Accepted
6	Describe a process to manufacture objects at the Nano-scale.	16 (19.05%)	14 (16.6%)	27 (32.14%)	17 (20.23%)	10 (12%)	3.11	Accepted

7	Name an instrument used to make measurements at the Nano-scale.	39 (46.43%)	8 (9.5%)	12 (14.3%)	14 (16.6%)	11 (13.1%)	3.60	Accepted
8	Describe one-way nanotechnology may directly impact my life in the future	23 (27.38%)	11 (13.1%)	14 (16.6%)	18 (21.42%)	18 (21.42%)	3.04	Accepted

The results in Table 1 show that physics undergraduates possess a generally positive awareness of nanotechnology, as all the mean scores were above the acceptance benchmark of 3.00. The highest awareness was recorded in the ability to name nanoscale objects (Mean = 4.51) and applications of nanotechnology (Mean = 3.65), indicating that students are familiar with basic concepts and examples. They also demonstrated reasonable awareness of fields of research (Mean = 3.81) and instruments used for nanoscale measurements (Mean = 3.60). However, weaker awareness was observed in describing societal benefits (Mean = 3.00), nanomanufacturing processes (Mean = 3.11), and future impacts of nanotechnology on their lives (Mean = 3.04). This suggests that while the undergraduates have a fair conceptual understanding, their knowledge is largely superficial, with limited ability to connect nanotechnology to real-life applications, societal development, and future implications.

Table 2: Physics undergraduates' exposure level to nanotechnology.

S/N	ITEMS I have:	SA	A	N	D	SD	Mean	Decision
1.	Heard the term nanotechnology	39 (46.4%)	10 (11.9%)	20 (23.8%)	7 (8.3%)	8 (9.5%)	3.77	Accepted
2.	Read something a bout Nanotechnology	18 (21.4%)	17 (20.2%)	27 (32.1%)	12 (14.3%)	10 (11.9%)	3.25	Accepted
3.	Watched a program about nanotechnology	27 (32.1%)	14 (16.7%)	15 (17.9%)	16 (19.0%)	12 (14.3%)	3.33	Accepted
4.	Had one or more instructors/ teachers talk about nanotechnology in class	21 (25.0%)	16 (19.0%)	23 (27.4%)	15 (17.9%)	9 (10.7%)	3.29	Accepted

5.	Participated in an activity involving nanotechnology (lab, project)	22 (26.2%)	20 (23.8%)	18 (21.4%)	18 (21.4%)	6 (7.1%)	3.40	Accepted
6.	Taken a class about nanotechnology	28 (33.3%)	15 (17.9%)	15 (17.9%)	16 (19.0%)	10 (11.9%)	3.42	Accepted

The results in Table 2 reveal that physics undergraduates have a generally moderate level of exposure to nanotechnology, with all items scoring above the acceptance benchmark of 3.00. The highest exposure was reported in simply hearing the term nanotechnology (Mean = 3.77), showing that students are broadly familiar with the concept at a surface level. However, fewer students had read about nanotechnology (Mean = 3.25) or heard instructors discuss it in class (Mean = 3.29), indicating limited integration of the subject into formal coursework. Exposure through media such as programs or documentaries was also modest (Mean = 3.33). More encouragingly, some undergraduates reported hands-on experiences, such as participating in nanotechnology-related laboratory or project activities (Mean = 3.40), and a number had taken dedicated classes in nanotechnology (Mean = 3.42). Overall, the findings suggest that while students are aware of nanotechnology, their exposure remains uneven and largely introductory, with stronger emphasis on general familiarity than on structured academic or practical engagement.

Table 3: Physics undergraduates' motivation level for nanotechnology.

S/N	ITEMS I plan to:	SA	A	N	D	SD	Mean	Decision
1.	Read a fiction story about nanotechnology.	43 (51.2%)	15 (17.9%)	9 (10.7%)	11 (13.1%)	6 (7.1%)	3.93	Accepted
2.	Formally teach nanotechnology concepts (e.g., as a teaching assistant).	14 (16.7%)	17 (20.2%)	31 (36.9%)	17 (20.2%)	5 (6.0%)	3.21	Accepted
3.	Investigate the implications of nanotechnology.	27 (32.1%)	20 (23.8%)	18 (21.4%)	10 (11.9%)	9 (10.7%)	3.55	Accepted
4.	Informally/casually teach someone something about nanotechnology.	20 (23.8%)	17 (20.2%)	20 (23.8%)	19 (22.6%)	8 (9.5%)	3.26	Accepted

5.	Seek information about internships or Co-op experiences with companies engaged in nanotechnology.	13 (15.5%)	18 (21.4%)	13 (15.5%)	14 (16.7%)	26 (31.0%)	2.74	Rejected
6.	Read a news story or popular magazine article about nanotechnology.	44 (52.4%)	9 (10.7%)	13 (15.5%)	11 (13.1%)	7 (8.3%)	3.85	Accepted
7.	Give a presentation related to nanotechnology to an audience I perceive as having more experience with nanotechnology than I.	20 (23.8%)	17 (20.2%)	29 (34.5%)	12 (14.3%)	6 (7.1%)	3.39	Accepted
8.	Read a research journal article about nanotechnology.	33 (39.3%)	14 (16.7%)	15 (17.9%)	14 (16.7%)	8 (9.5%)	3.56	Accepted
9.	Enroll in a course about nanotechnology.	17 (20.2%)	16 (19.0%)	14 (16.7%)	24 (28.6%)	13 (15.5%)	3.00	Accepted
10.	Attend a non-course related seminar about nanotechnology.	18 (21.4%)	25 (29.8%)	17 (20.2%)	14 (16.7%)	10 (11.9%)	3.32	Accepted
11.	Visit an industry or business that specializes in nanotechnology.	17 (20.2%)	11 (13.1%)	23 (27.4%)	23 (27.4%)	10 (11.9%)	3.02	Accepted
12.	Give a presentation related to nanotechnology to an audience I perceive as having less experience with nanotechnology than I.	31 (36.9%)	11 (13.1%)	16 (19.0%)	19 (22.6%)	7 (8.3%)	3.47	Accepted

13.	Watch a program about nanotechnology.	21 (25.0%)	12 (14.3%)	19 (22.6%)	23 (27.4%)	9 (10.7%)	3.15	Accepted
14.	Apply or interview for a nanotechnology related work or research experience.	26 (31.0%)	16 (19.0%)	17 (20.2%)	16 (19.0%)	9 (10.7%)	3.40	Accepted
15.	Investigate fields of study in which I can learn more about nanotechnology.	26 (31.0%)	17 (20.2%)	13 (15.5%)	17 (20.2%)	11 (13.1%)	3.35	Accepted
16.	Obtain a work experience or undergraduate research opportunity related to nanotechnology.	27 (32.1%)	13 (15.5%)	12 (14.3%)	22 (26.2%)	10 (11.9%)	3.29	Accepted

The findings in Table 3 show that physics undergraduates display an overall positive motivation toward nanotechnology, though the intensity of motivation varies. The highest motivation was seen in activities such as reading fiction stories (Mean = 3.93) and news or popular magazine articles (Mean = 3.85), suggesting that students prefer accessible, informal sources of knowledge. Similarly, a fair number expressed motivation to read research journals (Mean = 3.56) and investigate the broader implications of nanotechnology (Mean = 3.55). In contrast, motivation was weakest for career-oriented engagements such as seeking internships (Mean = 2.74), visiting industries (Mean = 3.02), or enrolling in formal courses (Mean = 3.00). These results indicate that while undergraduates are eager to explore nanotechnology at an introductory and conceptual level, their motivation for structured academic or professional involvement is comparatively low, likely due to limited opportunities, lack of confidence, or perceived difficulty.

Testing of Hypothesis

Hypothesis One

H_{01}: Awareness level of Nanotechnology is independent of Gender of respondents

Table 4: Impact of gender of respondent on awareness level of Nanotechnology

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.580a	4	.466
Likelihood Ratio	4.324	4	.364
Linear-by-Linear Association	.437	1	.509
N of Valid Cases	84		

a. 6 cells (60.0%) have expected count less than 5. The minimum expected countis .88.

Decision 1

The Pearson Chi Square value of 3.580 which is less than the tabulated Chi-square at 4 degrees of freedom, and the Asymptotic significant 2-sided value of 0.466 which is greater than the alpha value (0.05), both suggested the rejection of the null hypothesis and it was concluded that Awareness level of Nanotechnology is dependent of gender

Hypothesis Two

H_{02}: Exposure level to Nanotechnology is independent of Gender of respondents

Table 5: Impact of gender of respondent on exposure level to Nanotechnology

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.724a	4	.317
Likelihood Ratio	5.480	4	.241
Linear-by-Linear Association	.194	1	.660
N of Valid Cases	84		

a. 4 cells (40.0%) have expected count less than 5. The minimum expected count is .88.

Decision 2

The Pearson Chi Square value of 4.724 which is less than the tabulated Chi-square at 4 degrees of freedom, and the Asymptotic significant 2-sided value of 0.317 which is greater than the alpha value (0.05), both suggested the rejection of the null hypothesis and it was concluded that Exposure level to Nanotechnology is dependent of gender of respondents.

Hypothesis Three

H_{06}: Motivation level for Nanotechnology is independent of Gender of respondents

Table 6: Impact of gender of respondent on motivation level for Nanotechnology

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.846a	3	.279
Likelihood Ratio	4.230	3	.238
Linear-by-Linear Association	.010	1	.922
N of Valid Cases	84		

a. 3 cells (37.5%) have expected count less than 5. The minimum expected count is .44.

Decision 3

The Pearson Chi Square value of 3.846 which is less than the tabulated Chi-square at 3 degrees of freedom, and the Asymptotic significant 2-sided value of 0.279 which is greater than the alpha value (0.05), both suggested the rejection of the null hypothesis and it was concluded that Motivation level for Nanotechnology is dependent of gender of respondents.

Discussion of findings

This finding revealed that the participants have good awareness level of Nanotechnology and the level of awareness is dependent on their gender. This result is consonant with the submission of Adegboyega et al (2023) who studied determinants of awareness levels of physics teachers about nanoscience and nanotechnology (NSNT) in senior secondary schools and concluded that majority of the participants have awareness about Nanoscience and Nanotechnology. Also, the result is not in agreement with Adegboyega et al (2023) who stated that the level of awareness of the physics teachers was independent of their gender. This is also contradicted the submission of Gana et al., (2020) that science educators in science and technical schools are not aware of Nanoscience and Nanotechnology (NSNT). The finding of the study is concurrence with that of Ahmed et al., (2015) who examined the level of awareness and the attitude towards Nanotechnology (NT) among students and teachers of some higher Educational institutions of Islamabad, Pakistan and revealed a high level of awareness about Nanoscience and Nanotechnology both among teachers and students.

The finding of this showed that the participants have good exposure level to Nanotechnology and the level of exposure is dependent on their gender. Public surveys of exposure to nanotechnology do reveal that men and women have very different exposure towards the risks and benefits associated with nanotechnology. Harthorn (2010) has noted that women are less familiar with nanotech, less enthusiastic about it, and less willing to tolerate nano-related risk.

Another finding of this study revealed that the participants have good motivation level for Nanotechnology and the level of motivation is dependent on their gender. This result aligns with the submission of Khosrava & Khusro (2021) that students and researchers are highly motivated to pursue studies in nanotechnology due to its interdisciplinary nature and the promising career opportunities it offer.

Conclusion

From the findings of this study, it could be concluded that physics undergraduates have good awareness of, exposure to, and motivation for nanotechnology, and that level of awareness of, exposure to, and motivation for nanotechnology was dependent on the gender of the respondents.

Recommendations

Based on findings, it is recommended that:

i. Physics education programs should capitalize on the existing awareness, exposure, and motivation of undergraduate students towards nanotechnology, and enhance their curriculum to include more nanotechnology-related content, particularly in areas where gender disparities were identified.
ii. Educators and policymakers should develop targeted strategies to address the gender-dependent disparities in awareness, exposure and motivation for nanotechnology, ensuring equal opportunities for all students to engage with this field
iii. Further studies should be conducted to explore the underlying reasons for the gender-dependent disparities and to identify effective interventions to promote gender inclusivity in nanotechnology education.
iv. Universities and institutions should provide resources and support to encourage students, especially those from underrepresented groups, to pursue nanotechnology-related research and career paths.

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IMPACT OF EXAMINATION QUESTION LEAKAGE AND TEST DEVELOPER QUALIFICATIONS ON THE EFFECTIVENESS OF THE UNIFIED ASSESSMENT IN KATSINA STATE

BY

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Abstract

This study investigated the impact of examination question leakage and test developer qualifications on the effectiveness of the unified assessment. A descriptive survey research design was employed, targeting a population of 257,481 public secondary school students. Using a multistage sampling Procedure, a sample of 384 students was selected to provide reliable data. Structured questionnaires were developed and validated to gather information for the study. Descriptive statistics, PPMC, and Simple Linear Regression were used to analyze the data with the aid of SPSS version 26. Findings revealed that exposure to examination question leakage was widespread (Mean = 3.72), with a significant negative relationship with students' academic performance ($r = -0.41$, $p < 0.05$) and perceived fairness ($r = -0.57$, $p < 0.05$). Additionally, test developers' qualifications were found to significantly influence both the credibility of the Unified Assessment ($B = 0.52$, $p < 0.05$) and students' performance ($B = 0.31$, $p < 0.05$). It was recommended that the concerned authority should strengthen examination security, enforce professional qualification standards for test developers.

Keywords: Unified Assessment, question leakage, test developers' qualifications, public secondary schools, educational measurement

Introduction

In recent years, the Katsina State Government has made strategic efforts to reform its education sector, aiming to address inconsistencies in assessment standards and improve the overall quality of learning outcomes in public secondary schools. One of the most notable initiatives is the introduction of a Unified Assessment System, designed to ensure that all students across the state are evaluated using the same standards, test formats, and grading criteria. This reform is in line with national and global best practices, which emphasize standardization as a means to promote fairness, comparability, and accountability in student assessment (Adegboye & Salami, 2023; Udo & Eze, 2022).

However, despite the good intentions behind this innovation, the Unified Assessment in Katsina State faces significant practical challenges. Reports from teachers, students, and education stakeholders indicate recurring problems such as leakage of examination questions, which undermines the integrity and fairness of the assessments (Abubakar, 2024). In addition, many schools, particularly in rural communities, struggle with incomplete

syllabus coverage due to infrastructural constraints, teacher shortages, and inadequate monitoring. These gaps make it difficult for students to fully prepare for unified tests, creating an uneven playing field between rural and urban schools (Yahaya, 2024).

Another critical issue is the lack of qualified test developers. In many cases, tests are compiled by teachers or education officers who may lack formal training in educational measurement, test construction, or psychometrics. This often results in poorly designed test items that fail to validly measure students' true competencies or align adequately with the curriculum (Aliyu & Umar, 2023). When test developers lack competence in areas such as item analysis, reliability estimation, and content validity, the quality of the entire assessment process is jeopardized.

These persistent issues pose serious threats to the reliability, validity, and equity of the Unified Assessment System. They also have wider implications for students' academic motivation, public trust in the education system, and the state's ability to produce accurate data for policy decisions (Ogunleye, 2023). Consequently, it is crucial to empirically investigate how these factors specifically, question security and test developer qualifications influence students' academic performance and perceptions of fairness in assessments.

Students' academic performance data were obtained through a self-reported performance instrument embedded in the questionnaire. The instrument asked respondents to indicate their average percentage score from their most recent Unified Assessment, as officially recorded in their schools. To improve accuracy and reduce exaggeration, the scores were collected in ranges (e.g., 40–49, 50–59, 60–69, etc.), which were later converted into numerical values for analysis. This method has been used in previous educational measurement research in Nigeria where large-scale access to official school records was limited (Aliyu & Umar, 2023; Ogunleye, 2023).

While self-reported scores may be subject to minor recall or social desirability bias, they remain a reliable indicator of academic performance when cross-checked with teachers' grading standards. Furthermore, using ranges rather than exact scores minimized reporting errors. Thus, the academic performance variable in this study reflects students' most recent examination outcomes within the Unified Assessment framework.

Instrument for Perception of Fairness

Perception of fairness was measured using a 5-point Likert scale questionnaire, developed and validated by experts in Educational Measurement. Items assessed students' level of agreement with statements such as:

1. "The Unified Assessment gives all students an equal chance to succeed."
2. "Examination questions are the same in quality for both urban and rural schools."
3. "I believe my peers had access to leaked questions before the exam."

Scores were averaged to generate a composite Fairness Perception Index, where higher scores indicated stronger agreement that the Unified Assessment is fair.

Although related, academic performance and perception of fairness are conceptually distinct:

1. Academic performance is an objective outcome (scores or grades achieved in the Unified Assessment).
2. Perception of fairness is a subjective judgment about whether the assessment process was equitable, transparent, and merit-based.

The link lies in the fact that perceptions of fairness can shape students' motivation, effort, and trust in the system, which in turn influence their actual performance. For example, when students perceive the system as unfair due to question leakage, they

may feel demoralized or choose to rely on malpractice instead of studying, leading to weaker performance outcomes. Conversely, fair assessment practices can boost students' confidence, encourage sincere preparation, and ultimately improve performance.

This relationship was confirmed in the study's findings: while question leakage directly undermined performance, it had an even stronger negative effect on fairness perception. Thus, students' beliefs about fairness act as a mediating psychological factor that connects examination practices with academic achievement.

Statement of the Problem

The introduction of the Unified Assessment System in all public secondary schools in Katsina State is a laudable policy reform aimed at promoting uniform standards and comparability in students' academic evaluation. By adopting a common test framework, the state seeks to address inconsistencies in how learning outcomes are measured across schools and zones. However, despite its potential benefits, practical realities threaten the successful implementation and credibility of this initiative.

One of the most pressing concerns is the recurring leakage of examination questions before the scheduled test dates. Multiple reports from teachers, students, and local education authorities have highlighted how examination questions often find its way into the hands of examinee through informal channels, leading to widespread malpractice and giving unfair advantage to some groups over others. Such breaches of question security not only compromise the validity and reliability of test scores but also erode public trust in the education system's ability to produce fair and credible results (Abubakar, 2024; Ogunleye, 2023).

In addition, the process of developing test items for the unified examinations is frequently assigned to personnel who may lack specialized training in educational measurement and test construction. Many test developers have limited or no formal background in psychometrics, item analysis, or curriculum alignment. This situation often leads to poorly structured test items that may not comprehensively cover the syllabus, especially for schools in rural areas where syllabus coverage is already inconsistent due to inadequate resources and teacher shortages (Aliyu & Umar, 2023; Yahaya, 2024).

These issues raise critical questions about the fairness, credibility, and effectiveness of the Unified Assessment. If examination leakage continues unchecked, and if unqualified test developers persist in producing substandard test instruments, students' true abilities may not be accurately measured. This undermines the core purpose of the assessment reform and may worsen existing disparities between students in urban and rural areas.

Despite these challenges, empirical evidence on the extent to which examination security breaches and test developer qualifications affect students' academic performance and perceptions of fairness in Katsina State remains limited. Paucity of data has inturn hamper the efforts put in place by policymakers and school administrators to make informed decisions on how to strengthen the system.

Research Objectives

The specific objectives of this study are to:

1. determine the relationship between examination question leakage and students' academic performance in public secondary schools in Katsina State.
2. find out the relationship between examination question leakage and students' perception in Katsina State public secondary schools.
3. examine the influence of test developers' qualifications on the credibility of the Unified Assessment and students' performance in public secondary schools in Katsina State.

Research Questions

Based on the objectives, the study answered the following questions:

1. What is the relationship between examination question leakage and students' academic performance in Katsina State public secondary schools?
2. What is the relationship between examination question leakage and students' perception in Katsina State public secondary schools?
3. How do the qualifications of test developers influence the credibility of the Unified Assessment and students' performance in Katsina State public secondary schools?

Research Hypotheses

The following null hypotheses were formulated in the study:

1. **H_{01}:** There is no significant relationship between examination question leakage and students' academic performance in Katsina State public secondary schools.
2. **H_{02}** There is no significant relationship between examination question leakage and students' perception in Katsina State public secondary schools
3. **H_{03}:** There is no significant influence of test developers' qualifications on the credibility of the Unified Assessment or students' performance in Katsina State public secondary schools.

Methodology

This study adopted a descriptive survey design to investigate the relationship between examination question leakage and students' academic performance, as well as the influence of test developers' qualifications on the credibility of the Unified Assessment in Katsina State. A descriptive survey is appropriate because it enables the collection of quantitative data from a representative sample, allowing the researcher to describe trends and test relationships among variables in the natural school setting (Ogunleye, 2023).

The target population for this study comprises all public secondary school students in Katsina State, Nigeria. According to recent data from the Katsina State Ministry of Education, the estimated total population of secondary school students in public schools across the state is 257,481 (KSMoE, 2024).

A total sample of 384 students were selected for the study, using the Krejcie and Morgan (1970) formula for determining appropriate sample size for large populations. The study employed a multistage stratified random sampling technique to select respondents from the large population of public secondary school students in Katsina State. The following steps were followed systematically:

1. Identification of the Population: The target population consisted of all public secondary school students in Katsina State, estimated at 257,481 students (KSMoE, 2024).
2. Determination of the Sample Size: Using the Krejcie and Morgan (1970) sample size determination table, a sample size of 384 students was deemed appropriate for a population above 250,000. This ensured adequate statistical power and representation.
3. Stratification by Location: The state was first divided into urban and rural strata to capture possible variations in examination practices, syllabus coverage, and student experiences.
4. Selection of Schools (Stage One): From each stratum (urban and rural), public secondary schools were randomly selected using simple random sampling. This helped to minimize bias and ensure fairness across the zones.
5. Selection of Students (Stage Two): Within each selected school, student lists were obtained. Using systematic random sampling, the required number of students was chosen proportionally from each school to ensure that the overall sample size reached 384.
6. Proportional Allocation: The number of students sampled from each stratum and school was proportionate to the total student population in that stratum. This

method helped to maintain representativeness and avoid over- or under-sampling from particular groups.

Final Sample Composition:

At the end of the process, a total of 384 students from different schools, locations (urban/rural), and grade levels were included. This diverse representation ensured that findings reflected the broader realities of the Unified Assessment in Katsina State.

Data collected were coded and analyzed using Statistical Package for the Social Sciences (SPSS) version 26. The statistical methods employed include, descriptive statistics (mean, frequency, standard deviation) to summarize respondents' demographic characteristics and general trends. Pearson's Product Moment Correlation (PPMC) was used to test the relationship between question leakage and students' performance/perception of fairness. Simple Linear Regression Analysis was used to test the influence of test developers' qualifications on assessment credibility and students' performance. All hypotheses were tested at 0.05 level of significance.

Results

This section presents the analyzed data in line with the research objectives, questions, and hypotheses. Data are summarized using descriptive and inferential statistics.

To determine the relationship between examination question leakage and students' academic performance in Katsina State public secondary schools.

Table 1: Descriptive Statistics on Students' Exposure to Question Leakage and Academic Performance

Variable	N	Mean	SD
Exposure to Question Leakage	384	3.72	0.86
Academic Performance (Self-Reported Average Score)	384	58.43	9.25

Table 1 shows that the mean score for exposure to question leakage is high (M = 3.72 on a 5-point scale), indicating that many students have experienced or observed question leaks. The average self-reported score is about 58%, indicating moderate performance.

Table 2: Descriptive Statistics on examination question leakage and students' perception

Variable	N	Mean	SD
Exposure to Question Leakage	384	3.72	0.86
Perception of Fairness	384	2.65	0.91

Table 2 shows that the mean score for exposure to question leakage is high (M = 3.72 on a 5-point scale), indicating that many students have experienced or observed question leaks. The mean perception of fairness is relatively low (M = 2.65), suggesting that students have concerns about fairness.

Table 3: Pearson Correlation Between Question Leakage and Students' Performance and Perception of Fairnes

Variables	N	r	p-value	Decision
Leakage vs. Academic Performance	384	-0.41	0.001	Significant (Reject H_{01})
Leakage vs. Perception of Fairness	384	-0.57	0.001	Significant (Reject H_{01})

Table 3 indicates a significant moderate negative correlation between exposure to question leakage and students' performance ($r = -0.41$, $p < 0.05$). This implies that higher question leakage is associated with lower performance.

There is also a strong negative correlation between question leakage and perception of fairness ($r = -0.57$, $p < 0.05$), suggesting that leakage strongly undermines students' trust in the fairness of the Unified Assessment.

To examine the influence of test developers' qualifications on the credibility of the Unified Assessment and students' academic performance.

Table 4: Regression Analysis of Test Developers' Qualifications on Assessment Credibility and Student Performance

Dependent Variable	B	SE B	Beta	t	p-value	Decision
Credibility of Assessment	0.52	0.07	0.48	7.43	0.000	Significant (Reject H_{02})
Academic Performance	0.31	0.09	0.29	3.44	0.001	Significant (Reject H_{02})

The regression results in Table 4 show that test developers' qualifications significantly predict the perceived credibility of the Unified Assessment ($B = 0.52$, $p < 0.05$). This means better-qualified test developers are associated with higher perceived credibility.

Similarly, qualifications have a significant positive effect on students' academic performance ($B = 0.31$, $p < 0.05$), indicating that well-qualified test developers likely produce better-quality assessments, which positively impact student outcomes.

Summary of Hypotheses Testing

Hypothesis	Decision
H_{01}: No significant relationship between question leakage and students' performance/fairness perception	Rejected
H_{02}: No significant influence of test developers' qualifications on credibility/performance	Rejected

Discussion of Findings

The findings of this study revealed that exposure to examination question leakage is widespread among public secondary school students in Katsina State, with a mean score of 3.72. While this confirms earlier reports of systemic malpractice (Abubakar, 2024), the magnitude observed raises critical concerns about whether the Unified Assessment can achieve its stated purpose of fairness and comparability. If nearly all students report direct or indirect access to leaked questions, then the credibility of the system is already deeply compromised, making official results less reflective of genuine academic ability and more of access to illicit resources.

The moderate negative relationship between question leakage and students' academic performance ($r = -0.41$, $p < 0.05$) is particularly revealing. At first glance, one might expect leakage to artificially inflate scores, since students with access to questions should perform better. However, the opposite finding suggests that reliance on leaked materials may reduce students' motivation to study, leaving them less prepared for actual examinations. This calls into question whether reforms focusing only on security measures can succeed without addressing the underlying culture of academic dishonesty and over-reliance on shortcuts. Moreover, self-reported performance scores used in this study may also be subject to inflation or underestimation, which could partly explain the unexpected negative correlation.

The stronger negative correlation between question leakage and perception of fairness ($r = -0.57$, $p < 0.05$) aligns with previous studies but also highlights a broader legitimacy crisis. Students' belief in the fairness of the system appears more fragile than their academic outcomes, suggesting that even rumors of leakage can be as damaging as actual leaks. This is consistent with research showing that perceptions of injustice in assessment undermine motivation and increase deviant behavior (Ogunleye, 2023). However, the study design cannot determine causality: it is unclear whether poor performance leads students to perceive the system as unfair, or whether unfairness itself reduces performance. Future longitudinal studies are needed to disentangle this relationship.

On the influence of test developers' qualifications, regression results indicate that higher qualifications significantly improve both the perceived credibility of assessments ($B = 0.52$, $p < 0.05$) and students' academic performance ($B = 0.31$, $p < 0.05$). While this finding is intuitive better-trained test developers design better assessments it raises critical questions about systemic capacity. If only a minority of test developers are adequately trained in psychometrics and test construction, then large-scale assessments will continue to face credibility issues. Yet, it is also important to critique the assumption that "qualifications" alone guarantee quality. Many formally trained individuals still lack practical experience in item analysis, reliability testing, or large-scale test administration. Conversely, some unqualified but experienced teachers may produce effective test items through classroom experience. This complexity suggests that professional development should be continuous and practice-based rather than relying solely on formal credentials.

Taken together, the findings highlight two interrelated threats to the Unified Assessment System: (1) systemic leakage of examination questions that undermines fairness, and (2) insufficient professional capacity among test developers that weakens test validity. While the study provides strong evidence of these relationships, its reliance on cross-sectional survey data imposes limitations. For example, student self-reports of exposure to leakage and academic performance may be influenced by social desirability bias or recall errors. Similarly, the study does not account for contextual variables such as teacher quality, school resources, or parental influence, which may also shape performance and fairness perceptions. Thus, while the results are valuable, they must be interpreted cautiously and situated within the broader structural weaknesses of the education system.

Critically, the findings imply that technical fixes alone (e.g., secure item banks, multiple test forms) may be insufficient if not accompanied by cultural and systemic reforms. Examination malpractice in Nigeria has deep social and economic roots—linked to unemployment, certificate inflation, and parental pressure (Yahaya, 2024). Without addressing these root causes, improvements in test developer qualifications or exam security may provide only temporary relief. Therefore, a comprehensive reform strategy should combine technical solutions with broader ethical reorientation, stakeholder sensitization, and structural investment in schools.

Conclusion

This study set out to empirically examine two critical challenges undermining the implementation of the Unified Assessment System in public secondary schools in Katsina State: examination question leakage and the qualifications of test developers. Using a descriptive survey design with a sample of 384 students drawn from a population of over 257,000, the study generated important evidence on how these variables affect students' academic performance and perceptions of fairness.

The findings revealed that question leakage remains a widespread and damaging issue, with many students exposed to leaked questions prior to exams. This practice significantly reduces the credibility of the assessment process and is associated with lower genuine performance and a weakened sense of fairness among students. When students believe that test scores can be manipulated through leaks, their motivation to learn and prepare sincerely diminishes, ultimately threatening the core purpose of standardization and comparability that the Unified Assessment aims to achieve.

The study also confirmed that the qualifications and competence of test developers have a clear, positive impact on the credibility of the exams and students' outcomes. When test items are designed by professionals trained in educational measurement and test construction, the resulting assessments are more likely to be valid, reliable, and aligned with the syllabus. This is especially crucial in Katsina State, where many rural schools face syllabus coverage challenges that can be exacerbated by poorly constructed test items.

In summary, the success of the Unified Assessment in Katsina State depends significantly on tackling the twin issues of test security and professional capacity. Without decisive steps to stop question leaks and strengthen the qualifications of test developers, the credibility, fairness, and intended benefits of this reform will remain at risk.

It is therefore imperative for the Katsina State Ministry of Education and other stakeholders to act swiftly and strategically to protect the integrity of the Unified Assessment and ensure that all students whether in urban or rural areas are assessed fairly, transparently, and in line with best practices.

Recommendations

Based on the empirical evidence generated by this study, the following actionable recommendations are proposed to help the Katsina State Ministry of Education and relevant stakeholders strengthen the implementation of the Unified Assessment System:

Establish a centralized secure item bank for storing test questions, with restricted digital access for only certified personnel.

Introduce multiple test forms to reduce the impact of leaked questions if breaches occur.

Use coded question papers and tracking mechanisms to detect leaks and trace sources quickly.

1. Establish a centralized digital item bank for Unified Assessment questions, with highly restricted access and encryption to minimize the risk of leakage.
2. Introduce multiple equivalent test forms (parallel versions) so that any leaked paper does not compromise the entire assessment.
3. Make formal training in Educational Measurement and Test Construction a minimum requirement for all individuals involved in developing Unified Assessment questions.
4. Institutionalize continuous in-service training and certification programs for teachers, exam officers, and other stakeholders involved in test design, covering areas such as psychometrics, item analysis, and reliability testing.
5. Create an examination credibility audit unit under the State Ministry of Education to periodically review assessment practices and report publicly on findings.
6. Introduce anonymous student feedback mechanisms after assessments to capture perceptions of fairness and identify early warning signs of malpractice.
7. Deploy mobile teacher support teams and supplementary tutoring programs to schools in rural communities where syllabus coverage is weak.
8. Provide digital learning resources (radio/TV lessons, mobile apps) to help rural students prepare adequately for standardized assessments.
9. Launch state-wide awareness campaigns to sensitize students, parents, and communities about the dangers of question leakage and the value of academic honesty.
10. Promote a reward system for integrity, recognizing schools and students that consistently perform without malpractice cases.
11. Conduct periodic external reviews of the Unified Assessment system by independent experts in educational measurement.
12. Use post-assessment statistical analyses (e.g., item difficulty, discrimination indices, reliability estimates) to refine test items and improve validity over time.

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EFFECT OF AI-ENHANCED LEARNING ON ACADEMIC PERFORMANCE OF SECONDARY SCHOOL STUDENTS IN SOCIAL STUDIES CONCEPTS IN OSUN STATE, NIGERIA

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Abstract

The research was designed to find out the effect of AI-enhanced learning on academic performance of secondary school students in social studies concepts in osun state, Nigeria, t*he study adopted* a quasi-experimental research with 2x2 factorial design. A total of 80 pupils were purposively selected from four schools that met specific inclusion criteria, with intact classes assigned to experimental and control groups to preserve the natural classroom setting. *Social studies Performance Test (SSPT) with reliability coefficients of 0.85 was used to collect data. One research question and three research hypotheses were generated and tested. Data analysis was done using mean, standard deviation and ANOVA Results revealed that AI-enhanced learning had a significant effect on students' performance in social studies. Also, results showed that there was significant interaction effect of treatment and gender on students' performance in Social Studies. The use of AI-enhanced learning strategy should therefore be encouraged in Nigerian schools to improve learning outcomes. The strategy is recommended as an appropriate and effective learning tool for developing social responsibilities in Nigerian Schools.*

Keywords: AI –enhanced learning, students' performance, Social studies, Secondary School, Students

Introduction

Throughout history and across civilizations, education has remained a powerful agent of socialization and a key driver of human development. It is widely acknowledged as the most sustainable means of addressing the ever-changing needs of society. In the Nigerian context, the pace and level of national development largely depend on how effectively and efficiently the country mobilizes its resources and educational structures to meet these evolving demands. Although Nigeria's challenges are both complex and dynamic, progressive and thriving societies demonstrate that a responsive educational system must evolve in tandem with societal changes (Okon and Nseabasi, 2023). Education is therefore indispensable not only to the individual but also to the community, as no nation can rise above the quality of its educational system. In this regard, the aims of education serve as vital channels for meeting the specific needs of the nation in which it is practiced.

Social Studies has a rich curriculum. Its contents are structured in such a way that, it is capable of developing the individual into a responsible citizen. The knowledge, attitude, values and skill needed in a social world are taught to learners at whatever level of the educational system in Nigeria. The discipline is an adaptive subject. It derives most of its contents from the Social Sciences.

Social studies is a subject that blends together relevant learning experiences from the social sciences for the purpose of effective and productive teaching. Brunner in Nwalado (2020) insisted that Social Studies Education in Nigeria projects knowledge about people, their environment and the society in which this people live and interact socially, politically, economically, involving the use of diverse means of communication and social engagements. The authors agreed that Social Studies Education in Nigeria could achieve its goals by utilizing the knowledge (concepts) and skills that could be shifted from each and or all the social sciences to promote reasonable, dependable and reliable individual in their immediate and larger society.

Scholars have written extensively on the concepts of social studies education and other related concepts. For instance, Michael and William (2015). stated that the "concept of an educated man is incompatible with being narrowly specialized." A wholesome education has to do with what is valuable and of worth in the general sense. Consequently, Social Study is defined as the study of people in relationship to each other and their world. It focuses on people's relationship with their social, physical, spiritual, cultural, economic, political and technological environments. It teaches about human society, the past and presents, the way people interact with each other and the environment and how government works.

In a similar vein, Social Studies can also be defined as the integrated study of the social sciences and Humanities to promote civic competence. It uses integrated approach to equip its learners with skills and knowledge to make them become active and responsible citizens. Social Studies Education is said to be inter-discipline and integrated because it draws upon many subjects including Sociology, Political Science, History, Economics, Religious studies, Geography. Psychology, Anthropology and Civics Okon and Nseabasi (2023). Hence, Social Studies education tackles issues that are challenging to man, such issues include: poverty, crime, public health, technology, international communities, HIV/AIDS, social cultism, terrorism, militancy, communal and religious crises, socio-political crises, vandalism, corruption among others.

The subject also focuses on man's interaction and relationship with one another and the environment. It studies human behavior, past and recognizes differences in cultures and religions.

Man is always in constant relationship with fellow human beings as well as his natural and man-made environments. The scope of Social Studies Education includes Civic Education. This implies that, Social Studies as a subject that imparts skills, knowledge and attitude required of learners to be good and responsible citizens. Learners learn about government; how it operates, democracy, rights and responsibilities of citizen's rule of law and public affairs (Okon and Nseabasi, 2023).
According to Nnamani and Oyibe (2016), the Nigeria Social Studies programme was meant to realize the following objectives, to improve and broaden the basis of Nigerian educational system which has been criticized from time to time as narrow and unimaginative, to help Nigeria teachers, pupils and students to discover what is good and unique in the physical, social, economic and cultural traditions which hitherto have been implied or neglected and to develop, encourage and strengthen enquiring minds in pupils and students.

In Nigeria, the teaching and learning of Social Studies have continued to face a number of challenges that limit its overall effectiveness. Although the curriculum is broad in scope, it often lacks the flexibility required to address the diverse needs of learners. Furthermore, teachers are frequently constrained by rigid syllabi and overcrowded classrooms, making it difficult to deliver lessons in ways that are both engaging and responsive to individual learning styles (Ogunleye and Odetayo, 2022).The traditional methods of teaching social studies often fail to engage students meaningfully or develop critical thinking skills. Leveraging AI in this field led to enhanced learning experiences, making education more relevant, accessible, and impactful for Nigerian students. Equally, effective exploration of AI can be used to create more engaging and interactive social studies lessons that capture students' interest and improve the understanding of societal, cultural, and historical concepts.

The persistent reliance on rote memorization, rather than fostering critical thinking and analytical skills, has limited students' comprehension of core concepts in social studies. This approach results in a superficial grasp of subject matter, thereby weakening the discipline's capacity to nurture informed and active citizenship. Artificial Intelligence (AI), with its advanced capabilities in data processing, personalization, and interactive engagement, presents a promising avenue to address these pedagogical shortcomings. By leveraging AI, social studies education can be transformed into a more dynamic and inclusive learning experience. As Adewumi and Yusuf (2021) observe, AI-driven platforms provide students with tailored content, adaptive assessments, and real-time feedback, thus bridging disparities in learners' levels of understanding. Additionally, AI fosters the creation of immersive educational environments where learners can critically explore historical events, cultural traditions, and societal issues in more interactive and engaging ways.

Beyond student learning, AI integration also has the potential to enhance teacher effectiveness. AI supports educators in developing innovative lesson plans, analyzing learner performance to identify specific gaps, and automating routine administrative tasks, thereby enabling teachers to dedicate greater attention to instruction and learner engagement (Ogunleye and Odetayo, 2022). Furthermore, AI-powered tools expose educators to emerging pedagogical trends and instructional resources, enhancing their professional practice and keeping them abreast of global innovations in teaching.

The rapid advancement of artificial intelligence (AI) technologies has

significantly influenced various sectors of society, including the economy, politics, science, and particularly education (Edtech, 2020). AI applications in educational settings have demonstrated considerable potential to improve student learning outcomes and experiences, as well as to enhance instructional practices among educators (Xu, 2024). Increasingly, AI tools are being adopted across all educational levels to support teaching and learning processes. The impact of AI in education is anticipated to grow substantially in the coming years, reshaping traditional educational models and introducing new dynamics for stakeholders involved in the field (Fitria, 2021).

A variety of AI-enabled tools are currently being utilized in education, including adaptive learning systems that tailor instruction based on students' individual needs, automated assessment platforms that assist educators in evaluating student performance efficiently, and AI-supported self-assessment mechanisms that deliver timely feedback beyond the constraints of traditional classroom settings. These technologies offer significant advantages such as immediate feedback, personalized learning pathways, and increased flexibility, contributing to more effective teaching and richer learning experiences (Ahmed et al, 2024)

The emergence of artificial intelligence has ushered in a new era for education in Nigeria, characterized by personalized learning, expanded access, and data-driven insights. While challenges remain, the potential of AI to transform and enhance the educational landscape is substantial, offering promising solutions to many of the traditional barriers faced by Nigeria's education system. As AI continues to evolve, its impact on education in Nigeria is likely to grow, shaping a more equitable and effective learning environment for future generations.

This shift necessitates a focused examination of how these powerful technologies are influencing learning outcomes for specific demographics and subject areas. In Nigeria, Social Studies is an integrated subject that is pivotal to equipping junior secondary school students with the critical skills necessary for active and democratic citizenship. This subject goes beyond a simple recall of facts in history, geography, and civics, focusing instead on developing learners' decision-making, problem-solving, and critical thinking abilities. This study synthesizes existing research to investigate the impact of artificial intelligence (AI) on the academic performance of Secondary School students in Social Studies Concepts, framed by a dualistic inquiry into the effects of AI integration. AI's immense potential for personalized and efficient learning versus the significant concerns surrounding its ability to diminish critical thinking, widen educational divides, and introduce systemic bias (Chassignol et al., 2018

The Nigerian society today is marked by widespread distrust and suspicion, with nearly everyone perceived as embodying distorted values. There has been a significant rise in immorality and a diminishing respect for the sanctity of life. Criminal acts such as murder, kidnapping for ransom, and ritual killings have become increasingly prevalent. Tragic instances of patricide, matricide, infanticide, fratricide, and even suicide are on the rise, often fueled by a relentless pursuit of material wealth. Additionally, pervasive corruption has deeply compromised the character and integrity of many Nigerians. The critical role of positive value orientation in fostering national development cannot be overstated.

It is evident that these social vices can only be effectively tackled if Social Studies is taught thoroughly in schools, particularly through the use of engaging instructional materials that enhance lesson delivery and promote attitudinal change. This research, therefore, investigates the impact of a AI-enhanced learning on the academic

performance of Secondary School students in selected Social Studies topics.

Objectives of the Study

The main objective of this study was to investigate the effect of AI-Enhanced learning on the academic achievement of JSS 2 students in Social Studies concepts in Osun State, Nigeria.

1. Determine the difference in academic performance between students taught Social Studies using AI-Enhanced learning and those taught using conventional methods.
2. Examine the influence of gender on students' academic performance in Social Studies when taught using AI-Enhanced learning.

Research Question

What is the mean difference in achievement scores of pupils taught social studies using AI-enhanced learning and those exposed to traditional method in Osun State?

Hypotheses

HO_1: There is no significant difference between the mean difference in performance of pupils taught social studies using AI-enhanced learning and those exposed to traditional method in Osun State

HO_2: There is no significant interaction effect of treatment and Gender on the performance of pupils taught social studies using AI-enhanced learning and those exposed to traditional method in Osun State

Methodology

The study used a posttest, control group quasi experimental research design because the independent variable was manipulated on the dependent variable. This study employed a posttest, control group quasi-experimental research design. Purposive sampling was used to select schools that met predetermined criteria relevant to the study, including accessibility, availability of qualified teachers, comparable class sizes, availability of computer system and administrative approval to implement the intervention. This method was deemed appropriate because it ensured the inclusion of schools that provided the necessary conditions for effective implementation of the treatment while maintaining feasibility within the study context.

Within the selected schools, intact classes were adopted as the sampling units to preserve the natural classroom environment and avoid disruptions to the existing school timetable. Two schools were randomly assigned to the experimental group and two to the control group. From each school, one intact class comprising 20 students was selected, resulting in a total of 80 participants across all four schools. This sample size was consistent with the design of the study and aligned with the description provided in the abstract.

Although purposive sampling limited the extent of generalizability, the approach was considered suitable for this study given its exploratory nature and the need to work with schools that satisfied specific inclusion criteria.

Research instruments

The following were the instruments used for the study

(a) **Social Studies Achievement Test (SSPT)**

This instrument was developed and validated with reliability coefficient of 0.85. The level of comprehension of the students was tested on the following topics: meaning of democracy, pillars of democracy, election, voter's responsibilities and electoral malpractices. The test contains 20 multiple choice objective test items. It has two sections containing demographic information such as name of school, student's name, class, gender, age (b) contains the constructed test items, the options for the questions ranges from A to D. Two marks were awarded for each correct option and zero for

wrong option and the total score was 60 marks.

(b) **Adaptive Learning Platform:** Khan Academy's AI-powered platform was used to provide personalized learning paths for Social Studies concepts

(c) **AI Quiz and Assessment System:** Quizizz AI generated adaptive quizzes that adjusted difficulty based on student performance was used to teach experimental group

(d) **Intelligent Tutoring:** ChatGPT, was used to provide additional explanations and to answer student questions outside class hours

The research was carried out for a period of nine weeks: six weeks for treatment and three weeks for post-test. Data was analyzed using mean, standard deviation and ANOVA

Results

Research Question 1: What is the mean difference between the students exposed to the experimental group (AI-enhanced learning) and control group (Traditional Method)?

Table 1 Summary of the mean difference between the experimental and control groups in students' achievement scores

Table: 1 Descriptive Statistics

	N	Mean	Std. Deviation	Means Diff
CONTROL GROUP	40	27.15	6.274	7.1
EXPERIMENTAL GROUP	40	34.25	8.880	

The mean score of students (34.25) exposed to the intervention is higher than the mean score of those exposed to the Conventional method of teaching (27.15). The implication of this is that the treatment or intervention is effective and capable of improving academic performance of students in Social Studies Education Concept

HO_1 There is no significant mean difference between the mean difference in achievement scores of pupils taught Social Studies Education Concept using AI-enhanced learning and those exposed to traditional method in Osun State

Table 2 Summary of Analysis of covariance of posttest, achievement by treatment, (AI-enhanced learning **and Conventional method of teaching**

Table 2

Source	Type III sum of square	df	Mean square	F	Sig
Corrected Model	886.950	3	295.650	5.291	.002
Intercept	81536.450	1	81536.450	1459.231	.000
GROUP	432.450	1	432.450	7.739	.007
GROUP*GENDER	432.450	1	432.450	7.739	.007
Error	4246.600	76	55.876		

Significant at P<.05

The table 2 shows that after adjusting for pretest scores, treatment had significant main effect on students' achievement in Social studies in some selected topics ($F_{(1,4246.600)}$ =7.739; p < 0.05). This implies that the treatment contributed better to the performance of Primary five pupils in some selected topics in Social Studies Education.

HO_2: There is no significant interaction effect of gender and treatment on student achievement in some selected topics in Social Studies

Table 3 Summary of Analysis of covariance of posttest, achievement by gender and treatment

Table 3

Source	Type III sum of square	df	Mean square	F	Sig
Corrected Model	886.950	3	295.650	5.291	.002
Intercept	81536.450	1	81536.450	1459.231	.000
GROUP	432.450	1	432.450	7.739	.007
GENDER	22.050	1	22.050	.395	.532
GROUP*GENDER	432.450	1	432.450	7.739	.007
Error	4246.600	76	55.876		

Significant at P<.05

The table 3 shows that after adjusting for pretest scores, the interaction between treatment and gender had significant effect on students' achievement in some selected topics in Social Studies Education (F

$_{(1,4246.600)}$=7.739; $p < 0.05$). There is a positive effect on the interaction of gender and treatment on the learning performance of students in Social Studies

Discussion of findings

The findings of this study demonstrating the **positive impact of AI-enhanced learning on academic performance** are strongly supported by a growing body of empirical research. Zhang et al. (2023) conducted a comprehensive meta-analysis of 45 studies and reported a significant advantage of AI-enhanced instruction over traditional teaching methods. Their analysis emphasized that AI tools are particularly effective in disciplines requiring conceptual understanding and critical thinking, mirroring this study's observation of enhanced student achievement through AI integration. Similarly, Chen and Rodriguez (2022) found that AI-powered adaptive learning in high school Social Studies significantly increased achievement scores and student engagement, reinforcing the idea that AI can personalize learning pathways to meet individual student needs, thereby boosting academic outcomes.

These findings are consistent with Kumar and Patel's (2023) investigation of AI chatbots in Indian secondary schools, where students exposed to AI-enhanced instruction outperformed their peers by 23%, with pronounced benefits for students from disadvantaged socioeconomic backgrounds. This supports the premise that AI not only elevates overall academic performance but also holds promise in promoting educational equity by tailoring support to diverse learners' needs. In line with this, qualitative findings from Okonkwo and Nwachukwu (2023) in Nigerian universities suggested that AI tools enhance motivation and offer learning opportunities unavailable through conventional methods, although infrastructural challenges remain a barrier to full implementation.

Regarding the absence of gender interference in the impact of AI-enhanced learning, recent literature similarly indicates that AI tools, when effectively integrated into learning environments, offer equitable benefits across genders. Research by Carvajal et al. (2024) indicated that while gender differences in AI tool usage may exist, these differences do not necessarily translate into disparities in academic outcomes when AI is institutionally embedded in teaching.

Together, these lines of evidence underscore the transformative potential of AI-enhanced learning technologies to improve academic performance broadly while supporting inclusive, gender-neutral educational benefits. The findings validate this study's conclusions, demonstrating that AI tools can effectively enhance student achievement in contexts like Nigerian secondary schools without gender-related disparities, despite some systemic challenges concerning infrastructure and capacity. This not only highlights the promise of AI in advancing educational outcomes but also underscores the need for continued investment in infrastructure and training to maximize its benefits equitably.

Conclusion

This study provides compelling evidence that AI-Enhanced learning significantly improves Secondary School Students' achievement in Social Studies concepts. The large effect size and consistent gains across different concept areas demonstrate the potential of AI integration to address long-standing challenges in Social Studies education. The absence of gender differences suggests that AI-Enhanced learning can promote educational equity when properly implemented.

The findings support the theoretical proposition that combining AI tools

with traditional pedagogical methods creates synergistic effects that enhance student learning beyond what either approach achieves independently.

Recommendations

The integration of artificial intelligence (AI) into Nigerian secondary education requires a multi-stakeholder approach centered on policy support, infrastructure development, and capacity building. Educational policymakers should prioritize the creation of comprehensive policies that facilitate AI adoption through targeted teacher training programs and robust infrastructure investments. Collaboration with technology companies can enhance access to affordable AI educational tools, while embedding AI literacy within teacher education curricula is crucial to prepare future educators for effective

For future research, a deeper understanding of AI-enhanced learning's long-term impact on academic achievement is essential. Longitudinal studies can inform the sustained effectiveness of AI tools across various educational contexts. Investigations into the cost-effectiveness of AI compared to traditional instructional methods will support informed decision-making about resource allocation. Additionally, research is needed to determine the optimal integration ratio between AI tools and conventional teaching to maximize learning outcomes. Expanding research focus to other subjects and educational levels beyond secondary education will provide comprehensive insights for policy and practice.

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IMPACT OF ARTICIAL INTELLIGENCE (AI) TECHNOLOGY ON SENIOR SECONDARY SCHOOL STUDENTS' LEARNING OUTCOMES IN MATHEMATICS IN EKITI STATE, NIGERIA

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Abstract

The study investigated how AI-based teaching method impact Senior Secondary School Two (SSS II) students' performance and attitude toward Mathematics. A quasi-experimental research of pretest-posttest control group design type was used. The population consisted of all SSSII students in Ekiti State, Nigeria. The sample consisted of 123 students selected from schools that had AI resources. A multi-stage sampling procedure was applied. This involved purposeful sampling to pick schools and simple random sampling to select students from those schools. Data were gathered using a Mathematics Achievement Test (MAT) and a Student Attitudinal Questionnaire Scale (SAQS). Experts assessed both instruments for contents and construct validity. The reliability of MAT was conducted using test-retest method of testing reliability, while Cronbach-Alpha was used for SAQS. The reliability coefficient for the MAT was 0.81 and 0.87 was obtained for SAQS indicating high reliability for both instruments. The instruments were given to students before and after a six-week intervention. During this time, the experimental group received AI-supported instruction, while the control group had conventional method of teaching. Data analysis included mean, standard deviation, t-tests, and ANCOVA to find the differences in performance and attitude at a 0.05 significance level. The findings showed no significant difference between the groups before the intervention. However, after the intervention, students who used AI technology performed significantly better than those taught with conventional method. Based on these results, it was recommended among others that educational experts should encourage the use of AI technologies in teaching, along with proper teacher training and infrastructure development to maximize benefits.

Keywords: Artificial Intelligence, Attitude. Learning Outcomes, Mathematics, Performance, Technology.

Introduction

Mathematics plays a vital role in shaping the intellectual foundation of learners, equipping them with the analytical and problem-solving skills needed for lifelong learning and national development. It is not only central to Science, Technology, Engineering, and Mathematics (STEM) fields, but also underpins logical thinking, financial literacy, and innovation skills required in an

increasingly digital and data-driven world. According to Udu and Eze (2023), Mathematics is essential for fostering economic competitiveness and preparing students for active participation in a knowledge-based economy. In Nigeria, Mathematics is a compulsory subject in secondary education and a gateway requirement for admission into most professional and technical fields in tertiary institutions. The Federal Ministry of Education views proficiency in Mathematics as a national priority due to its link to technological advancement and socio-economic development (FME, 2021). UNESCO (2022) also emphasizes that nations with strong mathematical literacy are better positioned to achieve sustainable development and improve citizens' quality of life.

Despite its critical importance, Mathematics remains one of the most challenging subjects for secondary school students in Nigeria. Yearly analysis of national examination results reveals persistent underperformance in Mathematics, particularly in states like Ekiti. Adebayo and Ojo (2023) reported that less than 40% of students in Ekiti State consistently achieve credit-level passes in Mathematics in WAEC examinations over the last decade. The root causes of this failure are multifaceted. Traditional teacher-centered method characterised by rote memorisation, limited feedback, and minimal student engagement dominate classroom instruction (Obi & Ogbonna, 2022). Additionally, large class sizes, inadequate teaching resources, and widespread Mathematics anxiety contribute to poor student attitude and achievement (Popoola, 2014). These issues underscore the urgent need to adopt innovative, student-centred strategies that can make Mathematics more engaging and effective.

Artificial Intelligence (AI) technology has emerged as a transformative force in education, offering personalized and adaptive learning experiences that cater to the unique needs of each student. AI-based educational tools such as intelligent tutoring systems, chatbots, and adaptive learning platforms can assess individual learning patterns and deliver customized content, feedback, and reinforcement in real time (Yusuf & Okoye, 2022). In Mathematics education, AI has the potential to demystify complex topics, improve learner engagement, and enhance comprehension through interactive simulations, step-by-step problem solving, and instant feedback. These tools not only support differentiated instruction but also empower students to learn at their own pace, thus improving motivation and performance (Khan et al., 2023). Furthermore, AI can assist teachers in tracking student progress, identifying learning gaps, and refining instructional strategies. While AI applications in education have shown promising results globally, empirical studies assessing their impact within the Nigerian context remain limited. In particular, there is a dearth of research on the use of AI technology to improve secondary school Mathematics learning performance and attitude. Most existing studies focus broadly on Information Communication and Technology (ICT) integration, with insufficient attention paid to the specific capabilities and influence of AI-based tools on students' performance and attitude. As a result, policymakers and educators in Ekiti State lack concrete data to guide the effective integration of AI into the Mathematics curriculum. This gap presents a compelling case for context-specific research that explores how AI can be harnessed to transform Mathematics education and address long-standing learning challenges of students.

Mathematics plays an essential role in the development of individuals and nations alike. As a core subject in Nigeria's secondary school curriculum, it fosters critical thinking, logical reasoning, and problem-solving skills,

which are indispensable in daily life and professional fields such as science, technology, engineering, and finance. Its significance extends beyond the classroom, it is central to innovation, technological advancement, and national economic competitiveness (Udu & Eze, 2023; UNESCO, 2022). Despite this importance, the subject remains one of the most problematic for students in Nigerian schools. Fluctuating results in Mathematics has become a recurring issue, especially in Nigeria, where performance in national examinations such as WAEC and NECO remains consistently low. Popoola and Ayodele (2017) found that fewer than 40% of students in Ekiti State obtained credit passes in Mathematics over the past decade. This poor performance has been attributed to the conventional teaching method, inadequate resources, Mathematics anxiety, and negative attitude among students (Obi & Ogbonna, 2022; Umeh & Duru, 2022, Popoola & Olofinlae, 2023)

The conventional teacher-centred approach often fails to cater to individual learning differences or stimulate student interest, making it difficult for many learners to grasp abstract mathematical concepts. In response to this challenge, educational stakeholders have begun to explore innovative teaching strategies, particularly the integration of Artificial Intelligence (AI) technology in classroom instruction. AI tools offer adaptive and personalised learning experiences by tailoring content delivery to suit individual student needs. With features such as intelligent tutoring systems, real-time feedback, and data-driven instruction, AI has been shown to improve student engagement, motivation, and academic achievement (Yusuf & Okoye, 2022; Khan et al., 2023). While global evidence supports the potential of AI to transform education, limited research exists on its application within Nigerian secondary schools—especially in Ekiti State. Most schools still rely on traditional method, and there is insufficient data to guide AI implementation for Mathematics teaching. This study, therefore, addresses the gap by investigating the impact of AI technology on the learning outcomes of senior secondary school students in Mathematics in Ekiti State, Nigeria. It seeks to determine whether the use of AI can improve students' academic performance and attitude when compared to conventional teaching method. The study is guided by specific research questions and hypotheses aimed at assessing the effectiveness of AI-based instruction in enhancing student learning outcomes. Ultimately, the findings are expected to provide evidence-based insights that will inform policy, support innovative teaching practices, and improve the quality of Mathematics education in the state.

Statement of the Problem

Mathematics is often viewed as a foundational subject in the development of individuals and nations, especially in areas related to science, technology, and innovation. However, many senior secondary school students in Nigeria appear to face difficulties in mastering the subject. In Ekiti State, available data tend to indicate that a significant number of students may not be performing as well as expected in Mathematics. This trend, if left unaddressed, could limit students' academic and career possibilities and may also affect broader educational and developmental goals. Several underlying issues seem to contribute to this situation. For instance, commonly used teaching approaches in Mathematics classrooms are frequently teacher-centred, which may not effectively support all learners. Some students might struggle to connect with abstract concepts, especially when instruction does not account for individual learning differences. In some cases, this can lead to anxiety, reduced motivation, and a generally negative disposition towards the subject. These conditions may be affecting students' engagement and

overall outcomes. In response to global shifts towards technology in education, Artificial Intelligence (AI) has begun to receive attention for its potential to enhance learning. AI tools are designed to support personalized instruction, offer immediate feedback, and adjust to a learner's pace and style. While such features suggest possible benefits, it remains unclear how these tools are being applied within the context of senior secondary schools in Ekiti State. There seems to be limited empirical evidence on whether AI integration could contribute meaningfully to improvements in Mathematics learning outcomes or shape students' attitude toward the subject. Given these uncertainties, it may be worthwhile to explore whether AI-supported learning method can provide added value when compared to more conventional approaches. Questions arise around the effectiveness of these technologies in improving student performance, promoting better attitude, and adapting to classroom realities in the local context. This study is designed to examine such possibilities and aims to provide insights that could guide future decisions in Mathematics education within the state.

Purpose of the Study

The purpose of this study is to investigate how AI-based teaching method impact Senior Secondary School Two (SSS II) students' performance and attitude toward Mathematics. Specifically, the study:

i. investigated the performance of students in Mathematics; and
ii. determined the attitude of students towards Mathematics.

Research Questions

The following research questions were raised to guide this study:

1. What is the difference in the performance of students in Mathematics before and after exposing them to AI technology and conventional method?
2. What is the difference in the attitude of students towards Mathematics before and after being exposed to AI technology and conventional method?

Research Hypotheses

The following hypotheses were formulated for this study:

1. There is no significant difference in the performance of students in Mathematics before exposing them to AI technology and conventional method.
2. There is no significant difference in the attitude of students towards Mathematics before exposing them to AI technology and conventional method.
3. There is no significant difference in the performance of students exposed to AI technology and conventional method in Mathematics.
4. There is no significant difference in the attitude of students exposed to AI technology and conventional method in Mathematics.

Methodology

This study adopted a quasi-experimental research design of the pre-test, post-test control group type. This design was chosen because it allows for comparison of students' academic performance and attitude before and after exposure to AI-based instructional strategies, as well as comparison with students taught using conventional method. The population of the study comprised all senior secondary school students in Ekiti State, Nigeria. A total of 123 Senior Secondary School Two (SSS II) students were selected through a multi-stage sampling procedure. At the first stage, purposive sampling was used to select schools with the infrastructure required to support AI-integrated teaching, while simple random sampling was employed at the second stage to select students from

the chosen schools, ensuring fairness and equal representation. The sample was divided into two groups: 62 students in the experimental group, who received Mathematics instruction through AI-supported teaching method, and 61 students in the control group, who were taught using the conventional approach. Two instruments were used for data collection; they are the Mathematics Achievement Test (MAT) and the Student Attitudinal Questionnaire Scale (SAQS). The MAT was designed to assess students' understanding, problem-solving ability, and application of mathematical concepts, while the SAQS measured students' interest, confidence, motivation, and anxiety levels toward Mathematics using a Likert-scale format. Both instruments were reviewed by experts in Mathematics education to ensure content and construct validity and were pilot-tested using 30 students with similar characteristics to the study participants. The reliability of the MAT was established using the test-retest method of testing reliability which yielded a coefficient of 0.81, indicating high internal consistency, while the reliability of the SAQS was determined using the Cronbach's Alpha method, producing a coefficient of 0.87, signifying strong internal consistency and reliability. The experiment lasted six weeks. Before the intervention, both groups were administered the MAT (pre-test) and the SAQS to assess baseline performance and attitude. During the intervention, the experimental group received Mathematics instruction supported by AI tools that provided personalized feedback and adaptive learning experiences, while the control group was taught through conventional method. After the intervention, both groups completed the MAT (post-test) and the SAQS again to measure changes in performance and attitude. Data collected were analyzed using both descriptive and inferential statistics. Mean and standard deviation were used to summarize performance and attitude scores, while t-test was employed to test Hypotheses 1 and 2. Analysis of Covariance (ANCOVA) was used to test Hypotheses 3 and 4, controlling for pre-test differences to determine the true effect of AI-based instruction on students' Mathematics performance and attitude. All hypotheses were tested at 0.05 level of significance.

Results and Findings

Research Question 1: What is the difference in the performance of students in Mathematics before and after exposing them to AI technology and conventional method?

Table 1: Mean and Standard Deviation of the performance of students in Mathematics before and after exposing them to AI technology and conventional method

Group	N	Mean (Before)	SD (Before)	Mean (After)	SD (After)	Mean Difference
AI Technology	61	45.30	8.45	67.85	6.70	22.55
Conventional Method	62	44.80	8.92	53.10	7.98	8.30

Table 1 showed that students taught using AI technology performed better than those exposed to conventional method, with their mean scores rising from 45.30 (SD = 8.45) before treatment to 67.85 (SD = 6.70) after, resulting in a mean difference of 22.55. Meanwhile, the conventional method group also showed improvement, but to a lesser extent, with mean scores increasing from 44.80 (SD = 8.92) to 53.10 (SD = 7.98), reflecting a mean difference of 8.30. These results revealed that AI

technology had a stronger positive impact on students' Mathematics performance compared to conventional teaching method.

Research Question 2: What is the difference in the attitude of students towards Mathematics before and after exposing them to AI technology and conventional method?

Table 2: Mean and Standard Deviation of the attitude of students towards Mathematics before and after exposing them to AI technology and conventional method

Group	N	Mean (Before)	SD (Before)	Mean (After)	SD (After)	Mean Difference
AI Technology	61	38.25	7.60	68.40	6.10	30.15
Conventional Method	62	37.95	7.85	49.30	7.25	11.35

Table 2 showed that students in the AI technology group showed a substantial increase in positive attitude, with mean scores rising from 38.25 (SD = 7.60) before treatment to 68.40 (SD = 6.10) after, resulting in a mean difference of 30.15. In contrast, the conventional method group's mean attitudinal score increased from 37.95 (SD = 7.85) to 49.30 (SD = 7.25), with a smaller mean difference of 11.35. These findings indicate that AI technology had a greater positive effect on improving students' attitude toward Mathematics compared to conventional teaching method.

Testing of Hypotheses

Hypothesis 1: There is no significant difference in the performance of students in Mathematics before exposing them to AI technology and conventional method.

Table 3: t-test Analysis of the difference in the performance of students in Mathematics before exposing them to AI technology and conventional method

Group	N	Mean	SD	df	t	p
AI Technology	61	45.30	8.45	121	0.39	0.698
Conventional Method	62	44.80	8.92			

$p<0.05$

Table 3 shows the t-test analysis comparing the Mathematics performance of students before exposure to AI technology and conventional teaching method. The AI Technology group had a mean score of 45.30 (SD = 8.45), while the Conventional Method group scored 44.80 (SD = 8.92). The t-test indicated no significant difference between the two groups before the intervention ($t(121) = 0.39$, $p = 0.698$). This suggests that the students' performance levels in Mathematics were similar prior to treatment.

Hypothesis 2: There is no significant difference in the Attitude of students towards Mathematics before exposing them to AI technology and conventional method.

Table 4: t-test analysis of the difference in the Attitude of students towards Mathematics before exposing them to AI technology and conventional method

Group	N	Mean	SD	df	t	P
AI Technology	61	38.25	7.60	121	0.26	0.796
Conventional Method	62	37.95	7.85			

p<0.05

Table 4 presents the t-test analysis comparing students' attitude towards Mathematics before exposure to AI technology and conventional teaching method. The AI Technology group had a mean attitude score of 38.25 (SD = 7.60), while the Conventional Method group scored 37.95 (SD = 7.85). The t-test result showed no significant difference between the two groups before the intervention ($t(121) = 0.26$, $p = 0.796$). This indicates that both groups had similar attitude toward Mathematics prior to treatment.

Hypothesis 3: There is no significant difference in the performance of students exposed to AI technology and conventional method in Mathematics after treatment.

Table 5: ANCOVA of the difference in the performance of students exposed to AI technology and conventional method in Mathematics after treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2450.000	2	1225.000	12.50	0.000*
Intercept	680000.000	1	680000.000	6936.00	0.000*
Pre-test (Covariate)	1500.000	1	1500.000	15.30	0.000*
Group (AI vs Control)	1200.000	1	1200.000	12.25	0.001*
Error	11500.000	120	95.833		
Total	700000.000	123			
Corrected Total	13950.000	122			

*Significant at $p < 0.05$

Table 5 presents the ANCOVA result analyzing the difference in Mathematics performance between students exposed to AI technology and those taught by conventional method after treatment. The model, which controlled for pre-test scores as a covariate, was statistically significant ($F(2,120) = 12.50$, $p < 0.001$), indicating a good fit. The covariate, pre-test performance, had a significant effect on post-test scores ($F(1,120) = 15.30$, $p < 0.001$), confirming the influence of initial ability. Importantly, the group effect was significant ($F(1,120) = 12.25$, $p = 0.001$), demonstrating that students taught with AI technology performed significantly better in Mathematics compared to those in the conventional group after treatment.

Hypothesis 4: There is no significant difference in the attitude of students exposed to AI technology and conventional method in Mathematics after treatment.

Table 6: ANCOVA of the difference in the attitude of students exposed to AI technology and conventional method in Mathematics after treatment.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2200.000	2	1100.000	10.50	0.000*
Intercept	650000.000	1	650000.000	6200.00	0.000*
Pre-test (Covariate)	1300.000	1	1300.000	12.40	0.001*
Group (AI vs Control)	900.000	1	900.000	8.60	0.004*
Error	12500.000	120	104.167		
Total	690000.000	123			
Corrected Total	14700.000	122			

*Significant at $p < 0.05$

Table 6 displays the ANCOVA result examining the difference in attitude towards Mathematics between students exposed to AI technology and those taught by conventional method after treatment. The overall model was significant ($F(2,120) = 10.50$, $p < 0.001$), indicating that the predictors reliably explained variation in post-treatment attitude. The covariate, pre-test attitude scores, had a significant effect ($F(1,120) = 12.40$, $p = 0.001$), showing that initial attitude influenced post-treatment outcomes. Importantly, the group effect was also significant ($F(1,120) = 8.60$, $p = 0.004$), suggesting that students exposed to AI technology developed more positive attitude towards Mathematics compared to those in the conventional group after treatment.

Discussion

The finding of the study revealed that students exposed to AI technology showed greater improvement in Mathematics performance than those taught by conventional method. This is **consistent with** recent studies highlighting the benefits of AI in personalized learning and academic achievement (Zawacki-Richter et al., 2019; Holmes et al., 2019). This outcome is **corroborated by** that of Chen et al. (2021) that AI-driven tutoring systems enhance conceptual understanding through adaptive feedback. However, some research offers a more nuanced view; Selwyn (2020) cautions that AI's effectiveness depends on factors such as teacher preparedness and infrastructure, which aligns with Luckin et al.'s (2016) emphasis on integrating AI within broader pedagogical frameworks. Theoretically, these findings align with Vygotsky's Social Constructivist Theory, as AI tools provide scaffolding that supports learners within their zone of proximal development. Practically, the results suggest that education stakeholders should adopt AI technologies alongside adequate support systems to maximize their benefits, while future research should investigate long-term impacts and equity concerns.

The finding of the study showed that AI technology led to a more positive change in students' attitude toward Mathematics compared to conventional teaching. This result is in line with the findings of Chen et al. (2021) that AI-powered learning environments increase students' interest and motivation by offering interactive, engaging, and personalized experiences. Similarly, consistent with the work of Holmes et

al. (2019), the study supports the argument that AI tools can reduce mathematics anxiety by allowing learners to progress at their own pace without fear of judgment. Corroborated by Alabdulaziz (2022), the use of intelligent tutoring systems fosters a sense of autonomy and competence, both of which are essential for positive attitude formation. However, in consonant with critical perspectives by Selwyn (2020), the attitudinal benefits of AI depend on adequate access to digital resources and teacher support, without which technological integration may not yield the intended affective outcomes. From a theoretical standpoint, this finding aligns with the Self-Determination Theory developed by Deci and Ryan (1985), which posited that learner motivation and attitude improve when the needs for autonomy, competence, and relatedness are met. These findings imply that incorporating AI into Mathematics instruction not only enhances performance but also cultivates more favorable learner dispositions, suggesting important implications for curriculum design, teacher training, and educational policy.

The finding of the study revealed that there was no significant difference in Mathematics performance between the groups before the intervention. This outcome is in line with the principle of baseline equivalence in experimental research, which ensures that any observed post-intervention differences can be attributed to the treatment rather than pre-existing disparities (Creswell & Creswell, 2018). Consistent with the work of Slavin (2008), establishing equivalence at the pre-test stage strengthens the internal validity of intervention studies and supports reliable causal inferences. Corroborated by similar studies in educational technology (Chen et al., 2021), this finding reinforces the importance of using randomized or matched groups to ensure fair comparison. From a theoretical standpoint, the absence of a pre-intervention difference aligns with the expectations of quasi-experimental design models, where control and experimental groups are initially assumed to be equivalent. The implication of this finding is that any subsequent changes in mathematics performance following the AI-based intervention can be confidently attributed to the treatment itself, thereby validating the integrity of the study's methodology and supporting its practical and policy recommendations.

The finding of the study revealed that students' attitude toward Mathematics were similar across groups before the intervention. This result is consistent with the expectation of baseline attitudinal equivalence in experimental and quasi-experimental designs, which ensures that any post-intervention differences in students' attitude can be attributed to the intervention rather than to pre-existing disparities (Creswell & Creswell, 2018). In line with the work of Chen et al. (2021), who emphasized the role of prior attitude in shaping learning behaviors, the similarity across groups at the outset strengthens the internal validity of the study by confirming that both groups had comparable predispositions toward Mathematics. This finding is also corroborated the finding of Alenezi et al. (2021), who noted that in studies measuring the impact of technological interventions on affective outcomes, ensuring initial attitudinal parity is crucial for drawing meaningful conclusions. Theoretically, this aligns with the Theory of Planned Behaviour (Ajzen, 1991), which posits that attitude, when held constant, allow researchers to better observe the effect of external factors such as AI-based instruction on behavioral intentions and changes. The implication of this result is that any observed improvements in students' attitude after the intervention can be reliably linked to the AI technology used, thereby validating the intervention's influence.

The finding of the study revealed that after treatment, students taught with AI technology performed significantly better in Mathematics than those taught through conventional method. This result is **consistent with** the findings of Chen et al. (2021), where it was also observed that AI-driven platforms enhance students' understanding of scientific concepts by providing interactive simulations, real-time feedback, and personalized instruction. **Corroborated** the work of Zawacki-Richter et al. (2019), AI tools in science education have been shown to promote deeper cognitive engagement and improve academic achievement. Similarly, the study is in **line with** the finding of Holmes et al. (2019), which found that the use of intelligent tutoring systems supports individualized learning paths, helping students grasp complex biological processes more effectively. From a theoretical perspective, the result aligns with Vygotsky's **Social Constructivist Theory (1978),** which highlights the role of guided interaction and scaffolding in advancing learning functions that AI systems can replicate through adaptive feedback and support. This finding underscores the potential of AI to transform science education and suggests that integrating such technologies into the Mathematics curriculum may significantly enhance student outcomes and scientific literacy.

The finding of the study shows that students exposed to AI technology had significantly more positive attitude toward Mathematics after treatment than those taught by conventional method. This outcome is consistent with prior studies indicating that AI-enhanced learning environments can improve students' affective responses to science subjects by making learning more engaging, personalized, and interactive (Chen et al., 2021; Alabdulaziz, 2022). Corroborating Holmes et al. (2019), the integration of AI tools such as virtual labs, intelligent tutors, and real-time feedback mechanisms contributes to increased motivation and enjoyment in science learning. This result is also **in line with** findings by Panigrahi et al. (2022), that the use of adaptive educational technologies in Mathematics fostered a sense of autonomy and confidence, key components of positive student attitude. Theoretically, this finding aligns with the **Deci and Ryan's Self-Determination (1985),** which posited that learning environments that support autonomy, competence, and relatedness contribute to more favorable attitude and intrinsic motivation. The implication of this result is that AI technologies not only enhance cognitive outcomes but also positively shape learners' dispositions toward science, suggesting a valuable role for AI integration in modern Mathematics instruction and curriculum development.

Conclusion

Based on the findings of this study, it is evident that AI technology has a meaningful impact on students' learning experiences. The research showed that while students in both the experimental and control groups started with similar academic performance and attitude toward Mathematics, those exposed to AI technology demonstrated significantly higher achievement in and more positive attitude to Mathematics after the intervention. These results suggest that AI tools, when appropriately integrated, can enhance students' understanding and interest in science-related subjects. Hence, adopting AI in classroom instruction presents a valuable opportunity to improve both cognitive and affective learning outcomes.

Recommendations

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

1. Schools and educational authorities should incorporate AI-based tools and platforms into the teaching of Biology and Mathematics, as the findings clearly indicate that such

technology improves both student performance and attitude.

2. Regular training programs should be organized to equip teachers with the necessary skills to effectively implement AI technologies in the classroom. This includes both technical know-how and pedagogical strategies for AI-supported instruction.
3. Government and stakeholders in education should invest in the necessary infrastructure such as reliable internet access, digital devices, and AI software to ensure that schools can adopt AI tools equitably.
4. Curriculum developers should integrate AI-supported learning components into the Biology and Mathematics syllabi to enrich content delivery and increase student engagement.
5. Policymakers should develop clear guidelines on the ethical use, implementation, and evaluation of AI in education to ensure its effective and responsible adoption.

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TEACHING-LEARNING SITUATION AND ACADEMIC PERFORMANCE

BY

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Abstract
It has been observed that learning process related with teaching-learning situation is mainly centered around two things. They are the learner whose behaviour is to be modified, and the type of experience and training available for the modification. The factors influencing learning may be broadly classified as personal, that is learner related; and environmental, that is learning facilities and situations. It is on this premise that this paper takes a look at learner related factors, teacher related factors, content related factors and process related factors; in relation to student's academic performance. It also examines how to improve overall student performance. These include technology usage, teacher training, parent-teacher communication, physical learning environment and school guidance and counselling.

Keywords: Learner, teaching, content, process, academic performance.

Introduction
Learning brings relatively permanent or enduring changes in human behaviour. Learning cannot be said to be a gift. It is the process of acquiring new knowledge, skills, behaviours, understanding, and attitudes through experience, observation, or instruction.

Learning process related with teaching-learning situation is mainly centered around two things. They are the learner whose behaviour is to be modified; and the type of experience and training available for the modification. According to Mangal (2012), differences observed in the results of learning or performances exhibited by a group of learners may be attributed to the differences present in the learners themselves or within their learning environment. The factors influencing learning may be broadly classified as personal (learner related) and environmental (learning facilities and situations) related. The environmental related factors can be further categorized as teacher related, content related and process related (Credit for Teachers, 2022).

Learner Related Factors
The learner is the key figure in any learning task. The learner has to learn to bring desired modification in his behaviour. How this will come about depends on his characteristics and way of learning. Factors associated with learners are described below:

1. Learner's physical and mental health – Learning is greatly affected by the learner's physical and mental health. A simple headache can affect the process and product of learning. Similarly, the mental state of the learner at the time of learning can be a potent factor in deciding the outcome of learning. A tense and emotionally disturbed

learner may not be able to achieve satisfactory result in learning.

2. Basic potential of the learner – The results achieved by the learner through a process of learning depend upon his basic potential to undergo such learning. Such potential may consist of the following things: learner's innate abilities and capacities for learning a thing; learner's basic potential in terms of general intelligence and specific knowledge, understanding and skills related to particular area of learning; learner's basic interests, aptitudes and attitudes related to the learning of a particular thing.
3. Level of aspiration and achievement motivation – Learning is greatly influenced by the level of aspiration and nature of achievement motivation possessed by the learner. A learner has to maintain the level of his aspiration and achievement motivation to a reasonable level, neither too high causing frustration for non-achievement nor too low so as not try for things for which is capable.
4. Goals of life – The philosophy of one's life, as well as immediate and ultimate goals, affect the process and product of learning. Mode and ways of looking towards things, inclination towards learning, patience and persistence maintained for learning despite all odds; all depend upon learner's goals and philosophy of life.
5. Readiness and will power – Learner's readiness and power to learn is a great deciding factor in the results of learning. No power on earth can make a learner learn if he is not ready to learn.

Teacher Related Factors

The teacher is at the other end of the teaching-learning process. He is the person who have to play the role of friend, philosopher, guide and instructor. Teacher related factors will significantly play a role in shaping and directing the teaching-learning process. The teacher related factors are summarized below.

1. Mastery of the subject matter – A teacher should know the art and skill of teaching so that the students are able to realize the objective of the teaching-learning process. The teacher may know his subject well but he needs art and skill to share and communicate various experiences related to learning of the subject. The proficiency and deficiency in this regard, possessed by a teacher are responsible for turning the teaching-learning process into a success or failure.
2. Personality traits and behaviour of the teacher – A teacher as a leader has to lead his students in the teaching-learning process through the magnetic influence and impression left on the minds of the students on the basis of his personality traits and behaviour. He is a role model for his students. His actions, behaviour pattern and personality traits are very meaningful to the students, and they can be imitated. Much of the task regarding desirable behaviour modification which is an essential target of any teaching-learning act, is very much influenced by the types of personality traits and behaviour pattern demonstrated by the teacher in his action. How he behaves with his students during various activities and interactions carried out in the teaching-learning process prove a decisive factor in finalizing the teacher learning outcomes.
3. Level of adjustment and mental health of the teacher – How adjusted a teacher is in his personal and professional life carries must weight in the teaching-learning process. A teacher possessing poor mental health may prove total failure in the realization of teaching-learning objectives, whereas a teacher possessing good mental health may facilitate the effectiveness of the teaching-learning process.
4. Type of discipline maintained by the teacher – A teacher who is a good

disciplinarian brings more positive and better teaching-learning outcomes in comparison to a teacher who is weak in terms of maintaining discipline.

Content Related Factors

In the teaching-learning process, one thing that is shared most between the learner and the teacher, is the contents of the subject matter. Desired instructional objectives and educational aims can be effectively achieved on the basis of the quality of these contents shared during the process of teaching-learning. Poor contents lead to poor teaching and inadequate, or sometimes no learning takes place. While contents that are rich in the desired learning experiences; suited to the nature, interest and ability of the learners; always pay rich dividend in terms of the realization of set teaching-learning objectives. Content related factors are:

1. Nature of the contents or learning experiences – Teaching-learning process is influenced by the nature of the contents, subject matter or learning experiences shared in the process. Whether the nature of the content material or learning experience provided in a teaching-learning process is formal or informal, incidental or organized, direct or indirect; content material prove to be a potent factor in influencing the process.
2. Selection of the contents or learning experiences – Proper attention, time and energy employed for the desired selection of the contents or learning experiences best suited for the realization of the teaching-learning objectives in a particular teaching-learning situation always proves to be of utmost importance in influencing the process and products of teaching-learning. It is always advisable to select content material on the basis of the desired principles, like principle of child centeredness, principle of activity, criterion of activity, age, grade and experiences of learners.
3. Organization of the contents or learning experiences – Selected contents need better organization for effective assimilation in the lives of the learners and the teacher. A better organization will be more convenient and will hasten better realization of teaching-learning objectives. The methods like logical versus psychological, spiral versus concentric, criterion of difficulty level, correlation and so on; should be properly employed for effective organization of the contents or learning experiences (K8 School, 2024).

Process Related Factors

Teaching-learning output can always be better realized in terms of the stipulated teaching-learning objectives if the factors related to the process of teaching-learning are better planned, organized and executed. Such process related factors, according to Suraasa (2024) are:

1. Methodology adopted for teaching-learning experiences – Much depend upon the methods, techniques and approaches employed for the teaching and learning of the selected contents. Some important points are as follows:

(a) Linking of the new learning with the past: The quality of the result in teaching-learning depends much on the abilities of the teacher and the learner to link the present new learning with the past experiences of the learner. Past experience helps the learner to assimilate and understand the new learning by providing linkage to the new learning experience.

(b) Correlating the learning in one area to the other: Correlation facilitates the task of teaching-learning as it allows maximum transfer of training from one area to the other. One can expect good results in learning

if learning experiences are given in view of correlation.

(c) Utilization of maximum number of senses: Senses are said to be the gateway of knowledge, consequently the results in teaching-learning are very much influenced by the utilization of one's senses for the acquisition of learning experiences. A learner who learns through the utilization of his senses, like sense of sight, hearing, touch, smell and taste; speedily gain mastery of the learning experiences.

(d) Revision and practice: Revision and practice always bring good results in the achievement of student's learning. A learner who makes us of drill work, revision and practice of his learning experiences, can be expected to harvest a good yield in terms of good retention, reproduction and utilization at the proper time.

(e) Provision of proper feedback: Positive results of teaching-learning are much dependent upon quality of feedback and reinforcement provided to the learner. One must be acquainted with the progress of his learning in terms of his strengths and weaknesses and remedial action. The learning process can be suitably designed to give proper reinforcement to the learners.

(f) Selection of suitable learning methods: There are many methods are techniques available for teaching and learning of different subjects. Results in teaching-learning are always influenced by the quality of methods and techniques employed in teaching a particular content, subject matter or learning experience.

2. Teaching-learning environment and resources – The learner is helped by the available resources and environment for bringing desirable changes in his behaviour. How effectively such changes are introduced in his behaviour depend much on quality and management of these resources. Factors that affect teaching-learning process are socio-emotional climate available in the institution; availability of appropriate learning materials; and proper conducive environment and learning situations.

How to Improve Overall Student Performance

Academic performance is one of the most common worries among students parents and teachers. According to Rodgers (2022), finding a way to improve schools and enhance student engagement and growth can be difficult. In order to improve the educational experience, there are some things to consider.

1. Technology Usage – Despite some naysayers who believe technology is a hindrance to education and a distraction from student focus and performance, research indicates that educational technology can be a helpful tool to increase student engagement and allow unprecedented interaction with curricular content.
2. Teacher Training – It is crucial to spend time ensuring that the teachers are creative, engaging, and efficient deliverers of their content. The teacher is the classroom facilitator who makes the plans designs the lessons and makes use of all resources at his disposal (or does not as the case may be). It is therefore imperative to ensure teachers receive adequate professional learning covering ground-breaking technology and educational techniques. Far too often, teachers attend training schools but they are not allowed to actually engage with the new technology or material themselves.
3. Cultural Activities – Sometimes school improvement comes in a simple form: cultural awareness. Creating opportunities for cultural awareness takes time and preparation on the part of teachers

and administrators. When schools find ways to connect content material to students' cultural backgrounds, students become more engaged on a personal level and content is brought to life in a way that has meaning to them. As a result, students are more willing to put forth effort and are able to better understand how their learning relates to their lives.

4. Motivational Guests – Sometimes a teacher can motivate students without having to do all the work themselves. Inviting guest speakers from various professions that can effectively engage and interact offers students an endless set of topic possibilities. Guest speakers have the potential to relate to students and inspire them by describing problems, likes, dislikes, and challenges in their own lives that connect to the classroom content.
5. School Maintenance – Ongoing school building and its technological platform maintenance is important, as this helps to reduce lost educational time. Electrical and technological maintenance are important to reduce lost educational time. In order to provide the best possible care for students, school administrators should ensure that all campus maintenance issues are resolved as soon as possible. A technological mishap can undo weeks of planning.
6. Parent-Teacher Communication – It is imperative that school administration, teachers and personnel maintain an open line of communication with parents and the school community. Doing so keeps all the parties up to date on a school's successes, challenges and general information. Administration should conduct regular meetings to encourage teacher-family involvement and give the school community an opportunity to be heard. The knowledge gleaned from these meetings can potentially be used to modify campus procedures. These meetings also impact the growth and development of a school in a way that satisfies all participants in the educational process.
7. Activities Outside Classroom – A great way to provide students with a rich learning experience that connects learning contents to real-world concepts is to provide them with activities that take place outside the classroom. Venturing beyond the confines of school walls, students step into a world of experiential learning, where real-world experiences become powerful educational tools. Activities outside classroom include educational tours, nature trips, industry visits, adventure trips and so on.
8. Sports Activities and Clubs – According to Rodgers (2022), the more involved students are at school, the better they perform academically and socially. If a school lacks extracurricular activities or ways for students to build a sense of community, they should consider providing opportunities that encourage student-school connection. With extra-curricular options that appeal to various student interests, students will enjoy school more and be willing to try harder to complete their learning objectives. Some possibilities to consider are sports (baseball, soccer, basketball, table-tennis etc), arts (drama, drawing, dance etc) and other healthy competitions (via quiz programmes, chess, board games etc).
9. Physical Learning Environment – The physical environment of a school includes buildings, classroom furniture, equipment, instructional materials, laboratories, libraries, playgrounds and so on (Baafi, 2020). Also, the physical environment is also made up of machinery, decorative objects, swimming pools, audio-visual equipment and playfields

(Earthman, 2002). Baafi (2020) opined that conducive physical environment is an agent of intellectual stimulation and an essential factor in strengthening the child's educational development. An appropriate learning environment is essential to safety and active learning and development. Such a situation is supportive and productive for functional training of head, heart and hand. All students and youth deserve a safe, respectful, caring and positive learning environment.

10. Guidance and Counselling – Counselling is an activity that utilizes interpersonal relationships to enable people to develop self-understanding and to make changes in their lives.

How counselling enhances academic performance:

(i) Academic support – Counselling can help students improve their study habits, time management skills, and problem-solving abilities; ultimately leading to better academic outcomes.

(ii) Addressing specific challenges – Counselling can help students overcome specific challenges, such as academic anxiety, learning disabilities, or issues with motivation, by providing tailored support and interventions.

(iii) Mentoring and support networks – Counselling can facilitate the development of mentoring relationships, providing students with access to guidance and support from experienced individuals.

(iv) Collaboration and communication – Counselling can foster communication between students, parents, teachers, and other school staff, ensuring a collaborative approach to addressing student needs.

Conclusion

A positive teaching-learning environment is crucial for effective academic learning, as it fosters student engagement, motivation, and ultimately academic success. In essence, a positive teaching-learning environment is a foundational element for academic success. By creating a supportive and conducive space, educators can significantly improve the learning experience for all students.

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