



**MATHEMATICAL ASSOCIATION OF NIGERIA
(M.A.N)**

abacus

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**Editor-in-Chief:
Professor Muhammad Lawan Kaurangini, FICA**

Aliko Dangote University of Science and Technology, Wudil, Nigeria



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Editorial of Journal of the Mathematical Association of Nigeria, Abacus, Vol. 48, Number 1, April 2023

In this April 2023 edition of Abacus, the Journal of the Mathematical Association of Nigeria, we are excited to delve into the evolving landscape of mathematics education. As we navigate through the 21st century, the role of mathematics in our daily lives, as well as in the broader context of global development, continues to expand. This issue, therefore, focuses on innovative approaches, emerging trends, and the critical importance of fostering mathematical thinking in our educational systems.

1. The Imperative for Innovation

The traditional methods of teaching mathematics, characterized by rote learning and memorization, are increasingly being challenged. The modern world demands a shift towards a more dynamic, problem-solving, and application-based approach. Innovative teaching strategies, such as the use of technology, flipped classrooms, and project-based learning, are proving to be effective in enhancing student engagement and understanding.

2. Technology in Mathematics Education

One of the most significant changes in recent years is the integration of technology into mathematics education. From digital textbooks and online resources to interactive software and virtual classrooms, technology is transforming how students learn and how educators teach. Tools like computer algebra systems (CAS), dynamic geometry software, and educational apps provide students with hands-on experiences and immediate feedback, making abstract concepts more tangible and accessible.

3. Emphasizing Critical Thinking and Problem-Solving

Mathematics education must go beyond teaching formulas and procedures. It should aim to develop critical thinking and problem-solving skills. Encouraging students to explore multiple solutions to a problem, engage in mathematical discussions, and apply their knowledge to real-world situations helps them to become more versatile and innovative thinkers. This approach not only prepares students for academic success but also equips them with essential skills for their future careers.

4. Equity and Access in Mathematics Education

Ensuring that all students have access to quality mathematics education remains a paramount concern. Disparities in educational resources, teacher quality, and learning environments can significantly affect students' mathematical experiences and outcomes. It is crucial to address these inequities by providing support and resources to underserved schools, investing in professional development for teachers, and creating inclusive curricula that cater to diverse learning needs.

5. The Role of Educators

Educators play a pivotal role in shaping the future of mathematics education. Professional development and continuous learning are essential for teachers to stay updated with the latest educational strategies and technologies. Collaboration among educators, sharing best practices, and engaging in research can lead to more effective teaching methodologies and improved student outcomes.

6. Conclusion

As we reflect on the current state of mathematics education and look towards the future, it is evident that embracing change and innovation is not just an option but a necessity. The articles in this issue of Abacus highlight various aspects of this transformation, from theoretical insights to practical applications. We hope that these contributions will inspire educators, researchers, and policymakers to continue striving for excellence and equity in mathematics education.

In conclusion, we extend our gratitude to all the contributors, reviewers, and readers of Abacus. Your dedication and support are instrumental in advancing the field of mathematics education in Nigeria and beyond. Let us work together to cultivate a generation of learners who are not only proficient in mathematics but also passionate about its possibilities.

Professor M. L. Kaurangini

Editor-in-Chief

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THE INFLUENCE OF ENVIRONMENTAL FACTORS ON STUDENTS ATTITUDE TOWARDS MATHEMATICS IN OBIO-AKPOR LOCAL GOVERNMENT AREA OF RIVERS STATE

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Abstract

The study investigated the environmental factors that affects secondary school students' attitude in the learning of Mathematics in Obio-Akpor Local Government Area of Rivers State. A twenty-item questionnaire was administered on two hundred randomly selected students from five senior secondary schools that fairly represent the entire schools. A sample of 200 students (male, 69; female, 131) was used for the study. Stratified random sampling technique was used to compose the sample. Four research questions were answered while two hypotheses were tested in the study at 0.05 level of significance. Mean was used to answer the research questions, and t-test was used to test the hypotheses. The results show that the teachers role affects students' attitude in learning Mathematics, the use of instructional material increase student' retention in Mathematics lesson, the school and classroom environment affect the interest of students in Mathematics and the respondents also agree that the duration of teaching affects the learning of Mathematics. It also shows that there is no significant difference between the attitude of boys and girls in Mathematics and also that there is no significant different between the mean attitude students in co-educational schools and students in single sexed schools. Recommendations among others are that, Students should be exposed to federal and state Mathematics competitions as well as Mathematics quizzes organized by different schools. Teachers should reinforce their students positively because this will help them immensely to participate in the class and other necessary things needed for improvement in Mathematics.

Key words: Influence, Environmental factors, Students Attitude, Mathematics.

INTRODUCTION

Mathematics is part of life and its creation, it has spread its tentacles in all parts of the world such that people from different works of life see and appreciate its scope and influence in national and human development (Ahumaraeze & Ekwueme, 2019). The importance of Mathematics for any nation aspiring for scientific and technological advancement cannot be over emphasized. Mathematics provides opportunity to inculcate permanent literacy and numeracy in an individual as well as laying a sound basis for scientific and

reflective thinking. Mathematics ideas played a significant role in the revolution of electronics, information technology (IT), the search for energy, ability to measure the effect of environmental hazards and so on Oloda (2017). According to Oloda (2017) Mathematics is the linchpin in the task of national capacity building in science and technology and therefore, any short comings in this subject constitute drawback to the achievement of science and technology objectives. According to Oloda (2017), Ale & Adetula (2010) highlights the intricate link of Mathematics to science and

technology, and opined that without the knowledge of Mathematics there will be no science and without science there will be no technology and without technology there is no modern society. There are many definitions of Mathematics. Mathematics is a science of magnitude, space, time and number that is very suitable in all discipline. This is because all the specialized field of studies are dependent on it for problem solving, navigation and prediction of outcomes (Chuku, 2018).

Mathematics is the study of the measurement, relationships and properties of quantities and sets. It is also about logical analysis, deduction, calculation within these patterns and structures (Ekwueme, 2013). More informally, one might say it is the study of “figure and numbers”. Mathematics from our everyday experience has a lot to do with human endeavors: Farming, Engineering, and Medicine and in the Political field. Mathematics is more than algebra-the language of symbols and relations; more than geometry –the study of shape, size and space and it is higher than numerical trigonometry, which measure distance and analysis. It is more involving than statistics-the science of interpreting data and graphs, infinity and limits (Odilli, 2006).

Mathematics is the fulcrum of all science subjects in any educational system of any nation. For a nation to grow or develop in technology, the teaching and learning of Mathematics and science becomes important. There is no science subject, which does not contain an element of mathematic.

Mathematics is taught from pre-primary to tertiary levels, as spelt out in the national policy on education (2014). It expands a child's reasoning horizon and is favored in educational policies, including 60 to 40

ratios for science and arts admission in Nigerian universities. Failure in Mathematics at the senior secondary certificate examination can deter professional courses at higher institutions (Ahumaraeze & Ekwueme, 2019).

Mathematics is essential for calculating a nation's economy, encompassing time, money, speech, and thought. It is crucial for specializing in fields like medicine, accountancy, computer science, physics, and chemistry in universities and polytechnics. Many students opt for less or no Mathematics-related courses like Igbo and social studies due to its importance. The aforementioned claim is supported by Martin (1999), who emphasized the value of Mathematics in the study of science and technology and further contends that a person's ability to comprehend it is severely hindered if he lacks mathematical security.

At this point, it is necessary to portray the importance of development of any nation. Mathematics plays an important role in the domestic life of humanity in every race in the sense that, before a pot of soup could be cooked; we need to know the proportion of water, pepper, salt and other condiments needed for the cooking. A farmer requires a good sense of ratio and estimation to enable him make good use of the number of yam tubers in his barn for a portion of land, and to know approximately the number of laborers needed for the cultivation of the farmland and also the amount it will consume.

The study of Mathematics is quite relevant to modern technology advancement. Its knowledge equips professionals to take a leap into the unknown in order to make life easier and more comfortable. Mathematics facilitates the economic and social life of the people and results to more progress. For example: The Global system of mobile (G S

M) Communication. Due to the contribution of Mathematics as a subject, many countries had tried not only to accord it as an important place in their curriculum but have tried to improve its teaching and learning (Ahumaraeze and Ekwueme, 2019).

Despite the early start, the subject still poses a threat to the students, which result in a lot of failure as revealed above. Some students are interested in other to sciences and social subject such as chemistry, economic, and so on, but the element of Mathematics in these subjects put them off, which results to some change in students' attitude to the learning of Mathematics.

Attitude means different things to different people but it can be defined as a state that influences or modifies the individual choices of personal action. Such influences can sometimes be observed in actions exhibited in overt behaviors.

The environment significantly influences students' attitudes towards Mathematics learning. A cool, quiet and serene environments fosters a positive attitude. A challenging environment with friction or conflict tends to foster a positive attitude. Classroom climate, or climate, positively influences Mathematics attitudes.

A noisy area can never develop positive attitude in students towards the learning of Mathematics, like teaching and learning of Mathematics where there is noise because it will distract the attention of students.

Several literatures had shown that students perform poorly in Mathematics, Ahumaraeze and Ekwueme (2019); WAEC Chief Examiners Reports and so many researchers have attributed the failure as a result of a lot of factors like Environmental factors. This has caused problems to both parents and students. The persistent annual failure of students in General certificate examination (GCE) ordinary level, WAEC,

NECO is nothing but a limiting factor to students' career choices and a serious threat to technological development in the country. Mathematics plays a crucial role in stimulating interests in various fields like economics, physics, chemistry, and geology. However, students often boycott Mathematics classes and view teachers as enemies. A simple procedure has been adopted to examine Mathematics teaching and learning, considering students, teachers, methods, subject matter, school, and society as a whole.

Statement of the Problem

Mathematics appears to be feared by the Students. The student's way of studying Mathematics should be regarded very seriously, if one wants to make his or her judgment. Mathematics in our schools today are taught and learnt with mixed feeling, coupled with the preconception that Mathematics is too difficult to be understood and general poor performance in Mathematics. Tests and examinations result have shown this. Some Researchers have attributed the failure/poor performance in Mathematics to a lot of factors like Environmental factors, Innovative strategies, Curriculum, etc. However, the poor performance of students in WAEC, NECO, JAMB on yearly bases, this kept the researcher thinking and the researcher asked the following questions: What is the problem confronting Mathematics education in Nigeria that could be responsible for the student poor performance in the subject? Does the teachers' attitude in Mathematics affect students' attitude to Mathematics? Does the use of instructional material increase student's retention in Mathematics? Does the school and classroom environment affect the interest of students in Mathematics? Does the time of teaching

Mathematics affect students understanding of Mathematics? In analyzing those problems, the researcher has packaged this study titled “The influence of environmental factors on student’s attitude towards Mathematics in senior secondary schools”.

Purpose of the Study

The purpose of this research is to investigate the influence of environmental factors on student’s attitude towards Mathematics. The study specifically looked at

1. How attitude of teacher affects the attitude of students towards Mathematics.
2. How Mathematics instructional materials can affect the interest/understanding of students in Mathematics.
3. Whether the school and classroom environment affect the interest of students in Mathematics.
4. To determine if duration of teaching affect students understanding of Mathematics.
- 5.

Significance of the study

This study would bring a change of attitude to the learning of Mathematics. The students would benefit from this study, as it will motivate them to study harder. Curriculum planners would benefit from the study, as it will make them know the level of achievement of the students in Mathematics, which is the mother of all sciences. The research would also be useful in promoting effective classroom teaching in our schools, guide teachers to review their method of teaching Mathematics in particular and science in general.

Scope of the study

The Study was restricted to SS I & SS II students of the selected senior secondary

schools in Obio-Akpor Local Government Area of Rivers State. There are twenty-three (23) senior secondary schools in Obio-Akpor Local Government Area, out of which five were used for the study. However, the researcher looked at the influence of environmental factors on students’ attitude towards Mathematics. The study considered also students’ interest to Mathematics and the retention of students on what they learn in Mathematics.

Research Questions

For a proper investigation into the influence of environmental factors on students’ attitude towards Mathematics in senior secondary schools in Obio/Akpor, the following questions guided the study:

1. Does the attitude of the teacher affect students’ attitude to Mathematics?
2. Does the use of Mathematics instructional materials affect students’ interest/understanding in Mathematics?
3. Does the school and classroom environment affect the interest of students in Mathematics?
4. Does the duration of teaching affect students understanding of Mathematics?
- 5.

Research Hypotheses

The following null hypotheses guided the study and were tested at 0.05 (95%) level of significant.

1. There is no significant difference between the mean attitudinal responses of male and female students’ in Mathematics.
2. There is no significant different between the mean attitude response of student in co-education (mixed school) and student in single sex school.

RESEARCH METHODOLOGY

This deal with the special methods involves in carrying out this research, it is concerned with the methods applied in the study. The methods include the;

Design of the study

The research design for this work is descriptive survey research design, which is used to investigate a condition or to learn the status of something to show pattern of distribution of the items of the population.

Area of the Study

This study was carried out in Obio – Akpor Local Government Area of Rivers State. The Local Government is made of twenty-three (23) Senior Secondary Schools, which include co-education and single sex's schools.

Population of the Study

The population of this study comprised all the 27,023 senior secondary school one (1) and two (2) students in Obio-Akpor Local Government Area of Rivers State. The information gathered from these senior secondary schools was used to answer affectively question relating to the influence of environmental factors on students' attitude towards Mathematics.

Sample and Sampling Techniques

The sample consisted of two hundred S.S. 1 & 2 students from (5) randomly selected senior secondary schools in Obio-Akpor Local Government Area. In each of the selected schools, forty (40) students in the senior secondary school class one and two students were used for the study.

The sampling technique used in this study is the simple random sampling in which all the students in the sample school have the equal chances of being selected. Random sampling

refers as the method or procedure of selection of a sample in such a way that all the individuals in as defined population have equal and independent chances of being selected. This implies that the selection of one individual does not affect in any way the selection of any other individuals. These schools were stratified into two (2): co-education, and single sex's secondary school. Two hundred (200) students were then selected by sample random sampling and used for the study as sample.

Instrument Used for Data Collection

The instrument used for these studies was questionnaire on the influence of environmental factors on students' attitude towards Mathematics. It was constructed and structured by the researcher in the format of strongly agreed, agreed, disagreed, and strongly disagreed. The items of the questionnaires were specially designed to investigate the influence of environmental factors on students' attitude towards Mathematics. The questionnaire which was made up of twenty (20) items was designed in such a way that each respondent would have freely respond according to his or her personal opinion by simply ticking (\surd) in the appropriate box provided.

Validation of the Instrument

In the validation of the instrument, Experts from the University of Port-Harcourt, face validated the instrument before they were administered. The experts applied their wealth of knowledge to validate the questionnaire items, made corrections and suggestions. Their views formed the basis for the validation of the instrument.

The Reliability of Instrument

Reliability refers to the degree of consistency with which a measuring

instrument measures whatever it is measuring. After the face validation, the items numbered twenty (20) subjected to a reliability construct using Cronbach Alpha. The coefficient of the reliability was found to be 0.73, which implies internal consistency.

Administration of instrument

The researcher used face-to-face method of administration to administer the instrument in the five selected secondary schools. The questionnaires were completely filled on the spot and retrieved. This ensured a hundred percent return.

Method of data Analysis

The data collected and converted to frequencies, mean and standard deviations were used to analyze the research question while t-test was used to test the hypothesis. The mean was computed by multiplying the frequencies of the responses under such category by the assigned nominal value and dividing the sum of the product by the number of respondents to the particular item. The following response formula was applied: $\bar{X} = \frac{\sum FX}{\sum F}$, Where \bar{X} = mean, $\sum F$ = Number of respondents. \sum = Summation. X = Nominal value. The cut off was calculated by adding the nominal value of the weights (which gave total of 10) divided by the number of opinion option (i.e., 4). Number of scaling items = $(4+3+2+1)/4 = 10/4 = 2.50$

When the mean is greater than 2.50, it implies that majority agreed to the item statement in the questionnaire, but if the mean is less than 2.50, it indicates that majority of respondents disagreed with the particular statement item referred to in the instrument.

RESULTS

Research Question 1

Does the attitude of the teacher affect students' attitude to Mathematics?

Table 1

S/N ITEMS

1. I hate Mathematics because my teacher calls me names.
2. Our teacher helps us solve Mathematics problem outside Mathematics class.
3. My teacher gives assignment in Mathematics class outside what he taught in classroom.
4. My teacher encourages me to do Mathematics problems on my own.
5. I enjoy Mathematics because my teacher is a very good Mathematics teacher.

Average mean

Based on the result in table 1 above, the average mean for all the items is 2.53 with standards deviation of 0.928. This is more than 2.50 cut off point; hence the respondents agree that teacher's role affects students' attitude in learning Mathematics.

Research Question 2

Does the use of Mathematics instructional materials affect students' interest/understanding in Mathematics?

Table 2

S/N	ITEMS	MEAN (\bar{X})	SD	DECISION
6.	Use of teaching materials makes Mathematics enjoyable.	3.50	0.62	Accepted
7.	I understand Mathematics better with the use of teaching aids.	3.22	0.83	Accepted
8.	My teacher uses many instructional materials during Mathematics class.	2.18	0.97	Rejected
9.	My teacher is resourceful in improvising instructional materials for teaching Mathematics.	2.47	0.92	Rejected
10.	My teacher is careful in using Instructional materials.	2.70	0.99	Accepted
Average Mean		2.814	0.866	

Based on the result in table 2 above, the average mean for all the items is 2.814 with standards deviation of 0.866. This is more than 2.50 cut off point there by implying that the use of instructional material increase student' retention in Mathematics lesson

Research Question 3

Does the school and classroom environment affect the interest of students in Mathematics?

Table 3

S/N	ITEMS	MEAN (\bar{X})	SD	DECISION
11.	We have enough classrooms for teaching Mathematics	2.64	1.00	Accepted
12.	Our classrooms are well ventilated for teaching.	2.39	1.05	Rejected
13.	Our school are allocated in a quiet environment.	2.73	0.94	Accepted
14.	We have enough space in our classrooms.	2.29	1.02	Rejected
15.	Our Mathematics class experience crowded situation.	2.64	1.06	Accepted
Average Mean		2.538	1.014	

Based on the result in table 3 above, the average mean for all the items is 2.538 with standards deviation of 1.014. This is more than 2.50 cut off point there by indicating that the school and classroom environment affect the interest of students in Mathematics.

Research Question 4

Does the duration of teaching affect students understanding of Mathematics?

Table 4

S/N	ITEMS	MEAN (\bar{X})	SD	DECISION
16.	We have enough time allocated for Mathematics.	2.71	1.10	Accepted
17.	I learn Mathematics best during morning period	3.60	0.63	Accepted
18.	Mathematics can be done interestingly for any Number of hours	2.77	0.94	Accepted
19.	Period of days (morning or afternoon) does not necessary affect Mathematics lesson.	2.60	0.94	Accepted
20.	Mathematics teacher does not miss his/her lesson period in Mathematics because he/her likes Mathematics.	3.20	0.97	Accepted
Average Mean		2.976	0.916	

Based on the results in table 4 above, the average mean for all the items is 2.976 with a standard deviation of 0.916. This is more than 2.5 cut of point; hence the respondents agree that the duration of teaching affects the learning of Mathematics.

Hypothesis One

HO₁: There is no significant difference between the mean attitudinal responses of male and female in Mathematics.

Table 5: t-test on Attitude of Students Based on Gender

Gender	N	\bar{X}	S.D	Df	t-cal	t-critical (2-tailed)	Significant
Male	69	2.60	0.92				
Female	131	2.76	0.92	198	-1.16	1.96	NS
Total	200	5.36	1.84				

The critical distribution table of the t-test at df=198 under $\alpha=0.05(5\%)$ for the 2 tailed test is 1.96.

Since the critical value is greater than the calculated value at alpha 0.05, the null hypothesis is accepted. This implies that there is no significant difference between the attitude of boys and girls in Mathematics.

Hypothesis Two

HO₂: There is no significant different between the mean attitudinal responses of students in co-education and students in single sex school.

Table 6: t-test on co-education and Single sex schools.

School	N	\bar{X}	S.D	Df	t-cal	t-cri (2-tailed)	Significant
Co-education	120	2.59	0.91				
Single sex	80	2.89	0.89	198	-2.30	1.96	NS
Total	200	5.48	1.80				

Having known the degree of freedom, then the table of critical distribution of the t-test at degree of freedom 198 under 95% confidence interval (i.e $5\% = 0.05$) for two tailed test is 1.96

Since the calculated value is less than the critical value at alpha 0.05. We accept the null hypothesis. This means that there is no significant different between the mean attitude students in co-educational schools and students in single sexed schools.

DISCUSSION OF FINDING

The purpose of this research is to investigate into the influence of environmental factors on student's attitude towards Mathematics are determined by the following variables; How attitude of teacher affects the attitude of students towards Mathematics, How Mathematics instructional materials can affect the degree of retention of what students have been taught, Whether the school and classroom environment affect the interest of students in Mathematics, To determine if duration of teaching affect students understanding.

The result from Table 1 shows that teacher's attitude affects students' attitude in learning Mathematics.

In the second table; the study revealed that the use of instructional materials make Mathematics enjoyable also that the students understand Mathematics better with the use of teaching aids. The study also revealed that their teachers are resourceful in improvising instructional materials for teaching Mathematics and are very careful in using instructional materials (that is, using instructional materials that relate to the topic being taught).

Based on the result in table 3 above, the response shows that there are enough classrooms for teaching Mathematics. Also, that most schools are located at quiet environment, all these contribute to induce positive students' attitude in mathematic. It equally revealed that they don't

have enough space in their classroom and do experience crowded situation. However, the school and classroom environment affect the interest of students in Mathematics.

The results in table 4 above, the responses show that enough time is allocated for Mathematics lesson. It equally revealed that Mathematics is understood best in the morning period. The student' responses show that Mathematics can be done interestingly for any number of hours. Also, period of the day (morning or afternoon) does not affect Mathematics lesson. The students accepted that their Mathematics teachers do not miss their Mathematics lesson period because they have interest in Mathematics. However, the duration of teaching does not affect the learning of Mathematics.

In the research hypothesis one; there is no significant difference between the mean attitude of male and female in Mathematics. The decision was based on rejecting the null hypothesis and accepting the alternative when the calculated value is greater than the critical value but if it is otherwise the null hypothesis is accepted. From the result obtained, the critical value is greater than the calculated value at alpha 0.05 level of significant; therefore, the null hypothesis is accepted.

While in research hypothesis two; there is no significant difference between the mean attitude of students in co-education and student in single sex, because the calculated value is less than the critical value at alpha 0.05 this resulted in accepting the null hypothesis.

CONCLUSION

The finding of the study provide support in respect to the influence of environmental factors on students' attitude towards Mathematics in Obio-Akpor L.G.A, the method used in collecting data was questionnaire. The sample consists of two hundred (200) students from the five sampled senior secondary schools in Obio/Akpor local government area of Rivers

state. The questionnaire consists of twenty (20) items each was completed by the students. The research shows that if student are motivated, their attitude toward any task is affected. This help in creating positive attitude in students learning of Mathematics. Teachers using variety of teaching methods can achieve this.

RECOMMENDATIONS

Following the findings of this study, the researcher makes the following recommendations:

1. The educational authority should pay attention to the training of teachers through short course; frequent workshops, seminars to the teachers in the field of Mathematics. This will acquaint the teachers on the need to use variety of strategies in teaching of Mathematics in order to achieve its aims and objectives.
2. Government should provide adequate fund for the supply of instructional materials for Mathematics just as it was for some other pure science.
3. Teachers should reinforce their student positively because this will help them immensely to participate in the class and other necessary things needed for improvement in Mathematics. They should

also show interest in Mathematics because it will help the students in developing positive attitude towards the study of Mathematics.

4. Student should be exposed to federal and state Mathematics competitions as well as Mathematics quizzes organized by different schools.

If all these recommendations are tackled or followed as expected, by the teachers and the educational authorities, the attitude of student towards the study of Mathematics must surely change.

SUGGESTIONS FOR FURTHER STUDIES

This study has opened up more areas of investigation in connection with secondary schools and the attitude of students towards the study of Mathematics. The researcher suggests that further research should be undertaken in the following;

- i. Investigation into the factors that guide the selection of a particular strategy for a Mathematics lesson.
- ii. Investigation into the behaviour of teachers in the classrooms and their relationship with the students.
- iii. Investigation into the type of reinforcement given by teachers to their students.

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VALUES AND ATTITUDES INFLUENCING STUDENTS LEARNING OF MATHEMATICS: CASE STUDIES CONDUCTED AT FEDERAL COLLEGE OF EDUCATION, ZARIA

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Abstract

Motivation is an important element that affects students' performance ability. Lecturer should therefore labor to find out values and attitude that affect the motivation of their students so that necessary actions can be taken to ensure students successful and enjoyable learning experience. This paper report results of a case study conducted at Federal College of Education, Zaria, regarding values and attitudes that affect students' performances toward learning of mathematics. a questionnaire of a dozen questions was used in the case study to obtain input from a sample of about 200 NCE students who are at various level of their studies. The results obtained show that good teaching, good grades and good job consciousness to be the major motivators for our students.

Key word: Values, Attitudes, Students performances, Mathematics

Introduction

High motivation and engagement in learning have consistently been linked to reduced dropout rates and increased level of students success (W. E. Blank, & Harwell, S. (2015)), (Dev. P. C., 2009, Kushman, T. W, Suber C. & Heamold K. P. (2010), Woods, E. G. 2010). Yet, keeping students interested in school and motivating them to succeed are challenges that present themselves year after year to even the most seasoned teachers. There are many factors that influence students interest and level of engagement in learning, and teachers have little control over most of them (Mariade, L. M. etal(2012). However, research has shown that teachers can influence students motivation; that certain practices do work to increase time spent on task; and that there are ways to make assigned work more engaging and effective for students at all levels (Anderman and Midgley, 2013); (Skinner and Belmont, 2012).

Motivation is generally considered being intrinsic or extrinsic. A student who is intrinsically motivated undertakes an activity "for its own sake for the enjoyment it provides, the learning its permits or the feeling of accomplishment it evokes". An extrinsically motivated student on the other hand perform "in

order to obtain some reward or avoid some punishment external to the activity itself" such as grades, stickers or teacher approval.

This paper seeks to find out how certain motivational values play a role in the study life of FCE zaria mathematics students. A questionnaire on motivational elements was designed for this purpose and distributed to a sample of FCE Zaria sciences students at various level of their studies.

There were twelve question in the questionnaire covering a range of motivational factors. The respondents in the case study were mainly students from the school of secondary education, sciences. There are some students also from the school of Business studies. Students involved were those studying the following courses.

Mathematics/Physics, Mathematics/Computer, Mathematics/ Economics, Mathematics/ Chemistry, Mathematics/Inter-science and Mathematics/Geography.

2. Students Survey.

Our case study was based on a survey containing one dozen motivational questions. Such questions has five options numbered 0 to 4 with some reverse semantic differentials as show in Table 1. ;

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Response tag	Response
0	No response
1	Strongly agree
2	Agree
3	Disagree
4	Strongly disagree

Table 1

Questions for which there were no responses have a tag of zero. A respondent was required to make a single selection for each question. In case where more than one selection was made the first selection was taken for use in the

analysis of the survey results. We discuses result of the survey in the last question ie question twelve

2.1 Teaching quality value; The main intent of this question is to probe students on the

significance of quality teaching of mathematics to their influences in academic courses. The question goes as follows.

Q1 Quality of teaching by a lecturer is a major reason that make me like mathematics course and put more effort in the course.

It is expected that students who are more intrinsically motivated would be more likely to

withstand low-quality teaching than students who are more extrinsically motivated.

Figure 1 depict result of our students responses to this question. The result show that about 63% of the responders strongly agreeing and about 30% agreeing that they are motivated by quality teaching of mathematics.

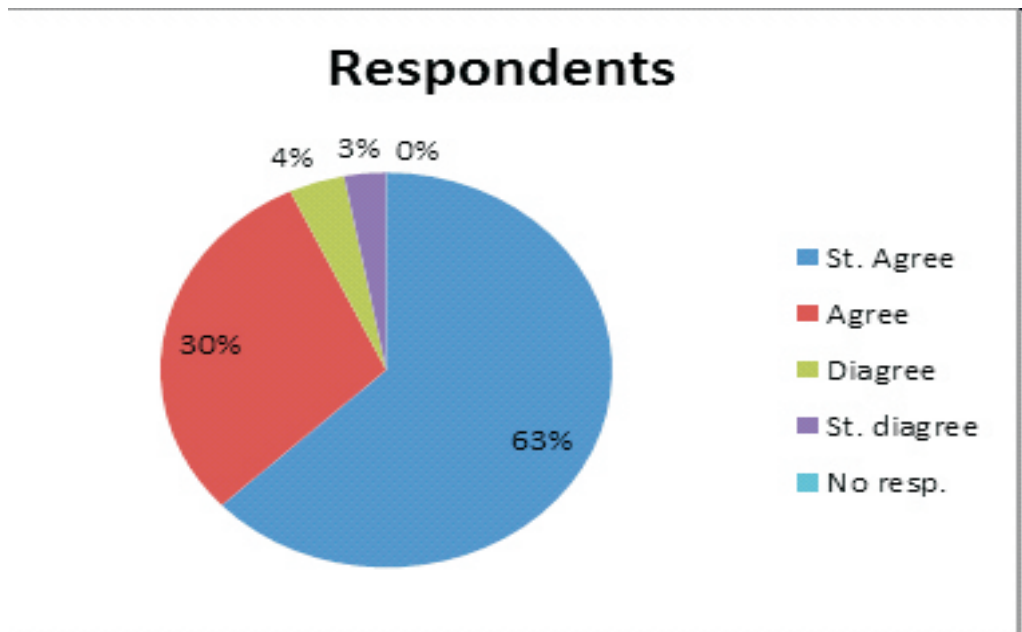
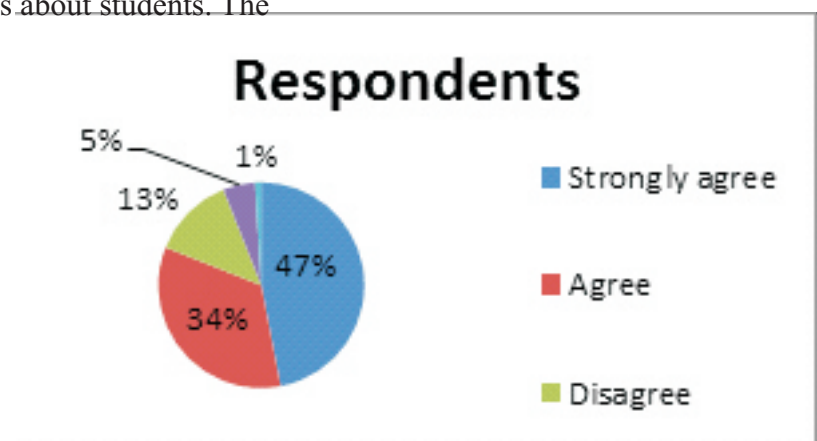


Fig1 Effect of quality teaching on students motivation.

2.2 Caring value;

The second question in the survey asks students about the role of mathematics lecturers care and concern of their welfare and their interest in the lecturer course. The statement of the question is; I easily lost interest in a course if the lecturer does not show that he cares about students. The

results show that 47% of the respondent strongly agreeing and about 34% agreeing that they easily loose interest due to uncaring lecturer behavior. About 13% of sample disagrees and about 5% strongly disagree to this question. As shown in the fig2 below.



Effect of uncaring lecturer behavior on students motivation

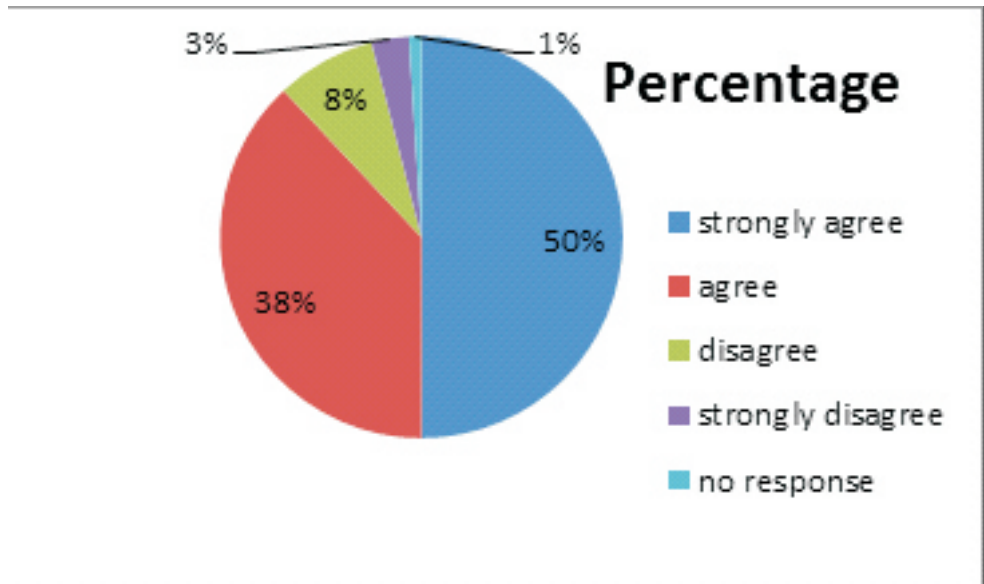
2.3 Grade value;

Students how do not yet have powerful intrinsic motivation to learn can be helped by extrinsic motivators in the form of rewards. For FCE students, the most valuable rewards are arguable grade. This question asks students the role of that

the grade plays toward their motivation.

Q3 A major reason that makes me put extra effort in a course is to get a good grade.

Figure3 show the students input on how grades play a role in their studies.



Effect of grade on students motivation

The result show that about 88% of the sample strongly agree or agree that they put extra effort in a course in order to get good grade. About 11% of the sample disagree that they put extra effort mainly to get good grade.

An important point to note is that extrinsic motivators can over a brief period of time, produce intrinsic motivation. Everyone not only students, like the feeling of accomplishment and recognition; reward for good work produce those good feelings.

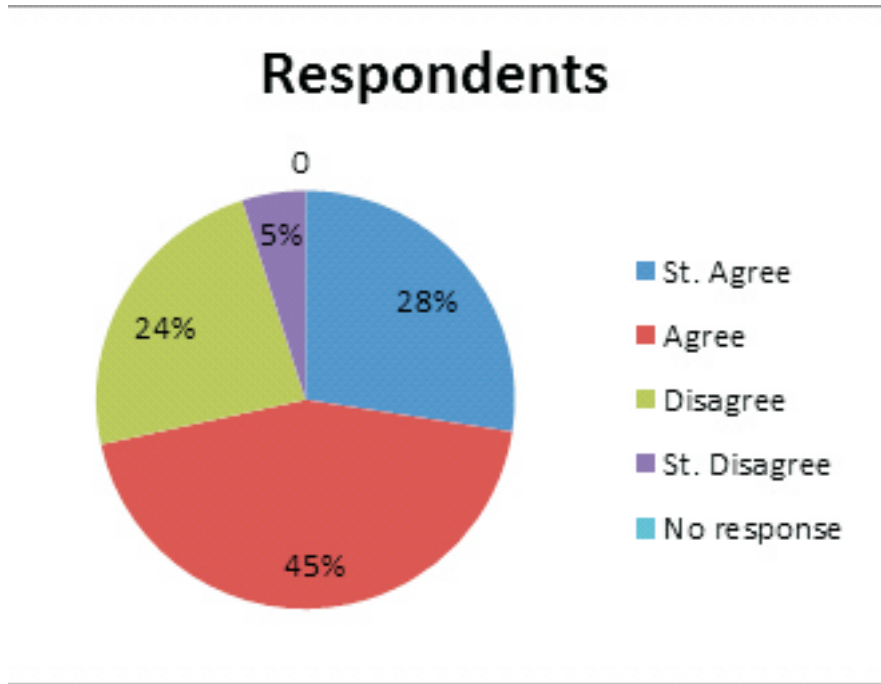
2.4 Competition value;

while some students may be motivated more by grades value others may be motivated more by

the love of overcoming challenges, example involvement or competition with their peers. Here we ask the following question.

Q4 I always want to do better than other students in my class. This is a strong reason that make me work harder in my courses.

Majority (about 70%) of the respondent here, show that the joy of doing better than others adds to their motivation. After all this questions has a direct consequence to the question on grades value because class average is a popular criterion for assigning grades to students. Thus a student's relative performance among his peers in a course is inextricable linked to his grade. Fig. 4 shows the responses on this question.



Effect of peer competition on students performances.

This figure show that a sizable number about 30% disagree or strongly disagree that competition with their peers give them a strong push to study. Motivation literature is also emphatic about the need to place more emphasis on task involvement rather than ego involvement (Edmone R. J. and Adler T. F. 2010). Following a standard grading scheme, as opposed to an averaging scheme, can be used to place more emphasis on task involvement.

2.5; Failure value.

Fear of failure is another delicate value that can have a strong effect on students motivation. Some students may take the negative side of this value and add more grease to their elbows while others, though motivated, may take the negative aspect of it and became apathetic.

Q5 I am always afraid of failure. This is why I work very hard in my course

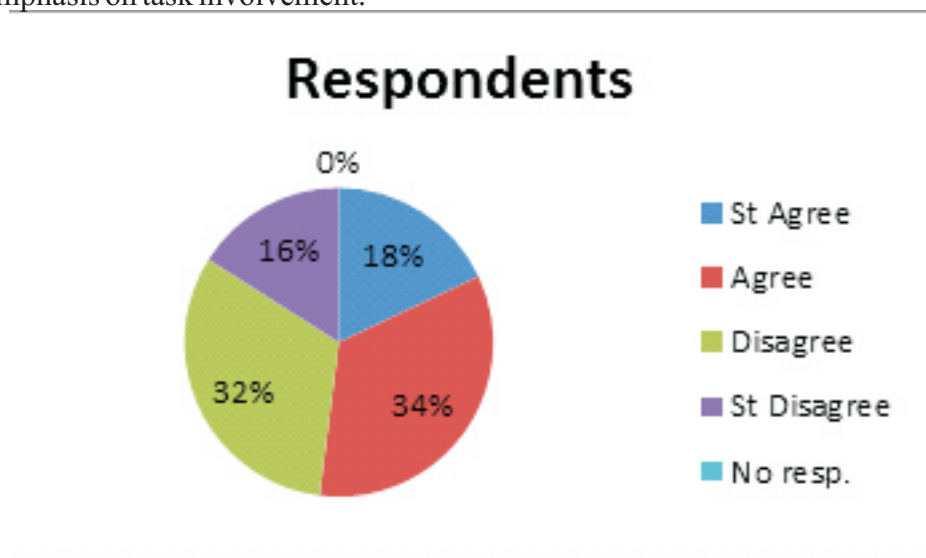


Fig5. Effect of fear of failure on students motivation

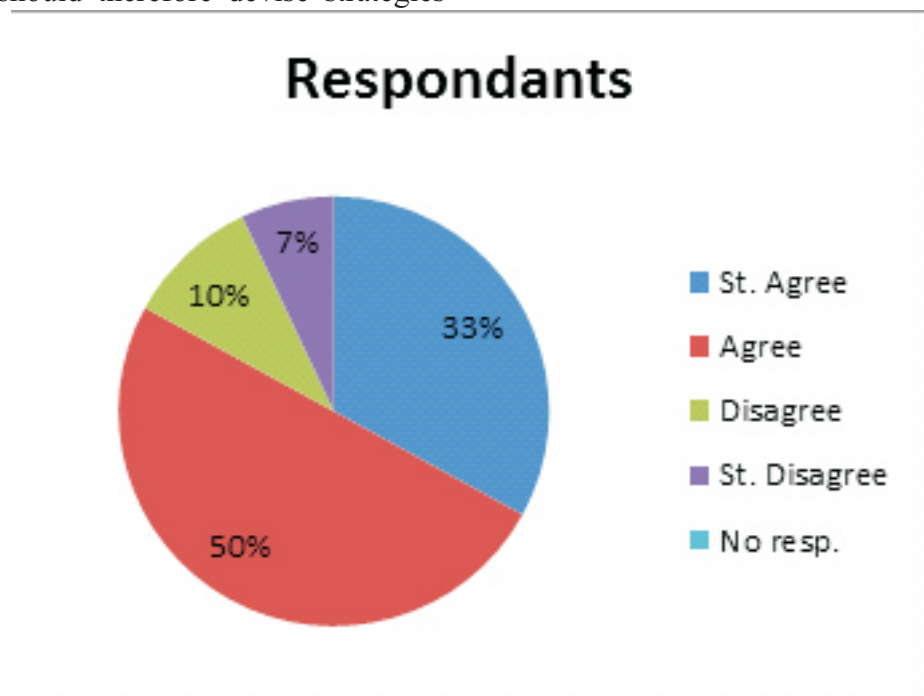
Results on this question, as shown in fig.5, are almost evenly distributed with about 18% strongly agreeing that work harder to avoid failure and about 16% strongly disagreeing. Also about 34 agreeing to this question while about 32% disagreeing.

Raffini, j. (2013) argues that students caught up in a system that dooms them to failure channel their motivation into behaviors that cover up that failure and thus protect their sense of self-worth. The philosophy of such apathetic students becomes "Nothing ventured, nothing failed". Educators (parents, Administrators and Instructors) should therefore devise strategies

that would remove motivational barriers and help students redirect their behaviors away from failure avoiding activities toward academic applications.

2.6 Job value.

Just as an overwhelming percentage of students said they study for grade, perhaps as an end in themselves, about 83% (about 33% strongly agreeing and 50% agreeing) indicated that they are motivated to get good grades as a stepping stone toward better job prospects. The question asked is as follows and fig.6 show the responses.



Effect of grades on job prospect on students motivation

On the other hand, about 17% of the respondents disagree or strongly disagree that the effect of their grades on their job prospect is not a motive for them to work harder.

2.7 Parents value.

The desire to make parents happy seems to be a major motivator amongst our students. This desire is, in a number of cases, triggered by some form of extrinsic motivator like holiday trip, new gift etc.

Q7 I put a lot of effort to get good grades to make my parents happy.

Figure7 shows that about 37% strongly agree, 42% agree, about 12% disagree and about 8% strongly disagree that they are motivated to work hard for the purpose of making their parents happy. One student had no opinion on this question. We should make efforts to redirect our students motivation more toward intrinsic values.

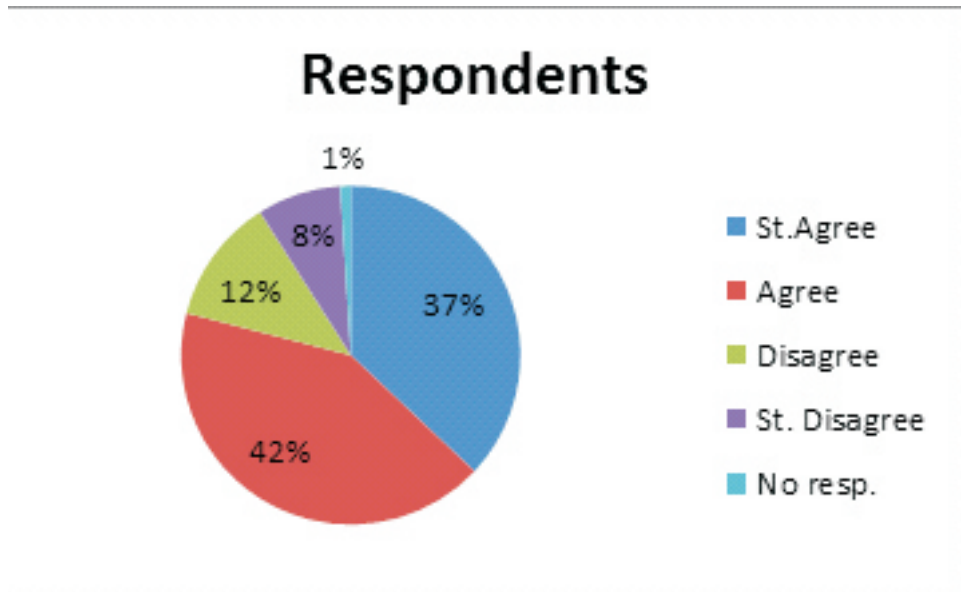


Fig7 Effect of parents on students motivation.

2.8 Self esteem value.

Peer praise is another form of extrinsic motivator. Certain students consider this as a vital need and work hard to actualize it

Q8. My friends know me as a good student. I work hard to maintain that. The respondents are shown in fig 8 below.

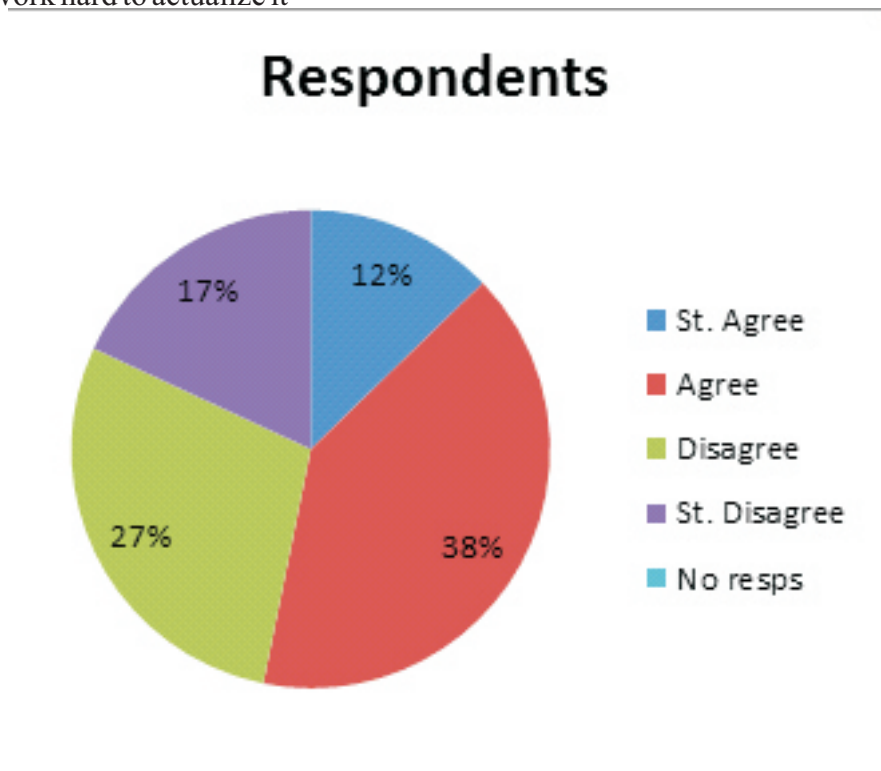


Fig8. Effect of peer recognition on students motivation.

As with question 5 above, fig8 shows that students opinion on the motivational value of this question is almost evenly distributed. A total of 94 students agree that peer recognition is a major motivator for them (21 of them strongly agreeing). On the other hand, 97 students disagree (34 strongly disagreeing) that they are motivated to maintain their self worth in the eye of their friends.

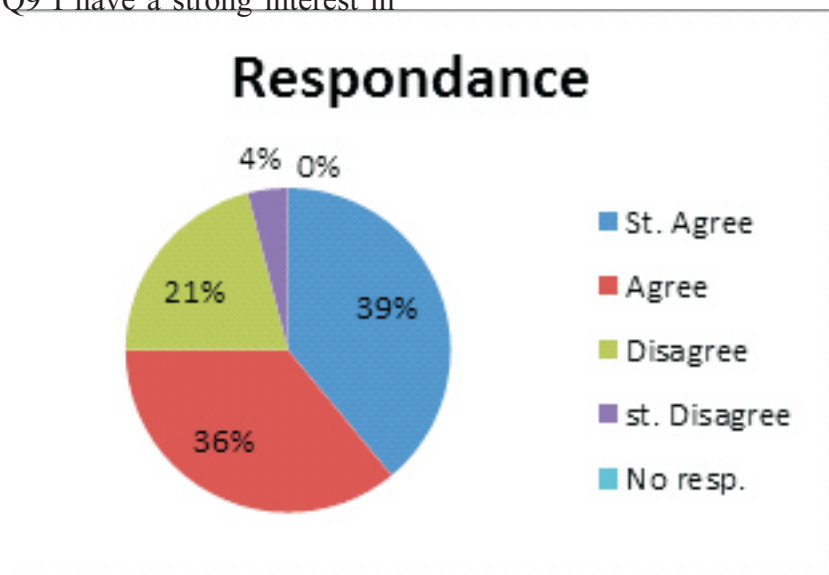
2.9 Interest value.

In this section we are asking a question that essentially probes students intrinsic motivation. The question is Q9 I have a strong interest in

learning. This interest. This interest is the main push for me to work hard in my courses.

Fig9 Effect of love of learning on students motivation.

A total of 75 students (about 40%) strongly agree and 69 students (about 21%) disagree and 7 students (about 4%) strongly disagree that love for learning is a major motivator for them fig9. These figure, together with students written comment on question 11 are encouraging only one quarter of our sample disagree that they learn for the enjoyment of learning. We should put extra effort to reduce this member further.



2.10. need value (Relevance).

One of the many issues students always raise, in my experience talking to students freely, is the relevance issue. A common concern is that students fail to appreciate the wisdom of

requiring them take courses outside their field of major.

Q10. I'm only interested in courses that I know I need later during my job experience.

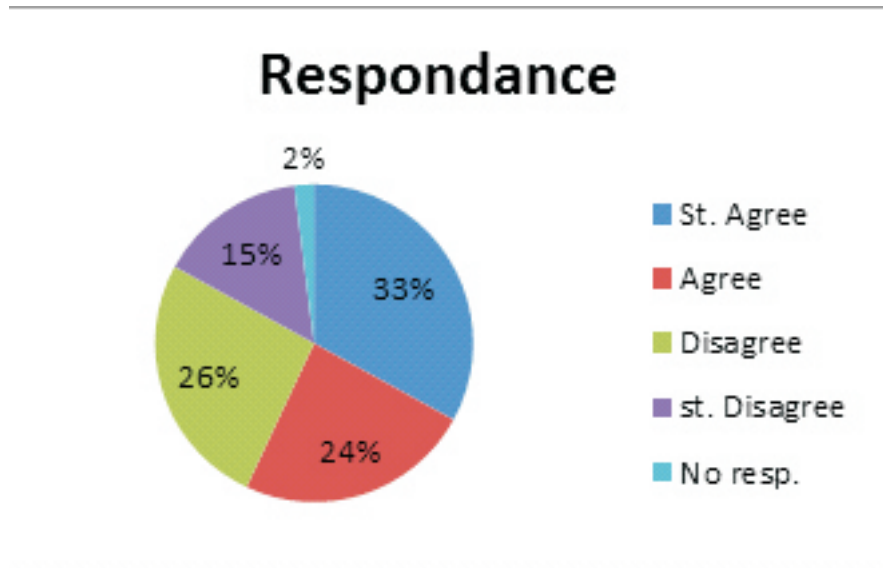


Figure 10. effect of course relevance on students motivation.

About 56% of the respondent say they agree or strongly agree that they are motivated on put effort in courses they believe they need later in their jobs. About 40% of the sample holds the opposite view. There three students that did not respond to this question. The percentage of those disagreeing with this statement is much lower than what I expected because many seem to express the same concern that they are not motivated in courses that they believe do not belong to their program major.

2.11. other value

In this question the respondents were requested to write down other values that affect their motivation. Some of the respondents emphasized on one or more of the values already discussed in previous subsections. Table 2 shows other statements collected from the completed questionnaires.

Other reasons that make you like or dislike leaning in Federal College of Education, Zaria	
Motivators	De-motivators
<ul style="list-style-type: none"> ✓ Lecturer mastery of subject ✓ To make a positive difference in our communities ✓ Making learning enjoyable and challenging. ✓ Money 	<ul style="list-style-type: none"> ✓ Pressure of work; many lecturers think that we have only their course to study. ✓ Hard exams questions. ✓ Unhelpful lecturers during their office hours ✓ Lecturer given low grades ✓ Too many students in a class. ✓ Too much home works ✓ Grade centre evaluation rather than creativity based evaluation. ✓ Taken courses not related to my major ✓ Theoretical courses that require memorization. ✓ Old ancient courses.

2.12. value ranking.

This question requested students to rank the values that affect their motivations the most.

Q12. Which of the above factors affects your interest in learning most?

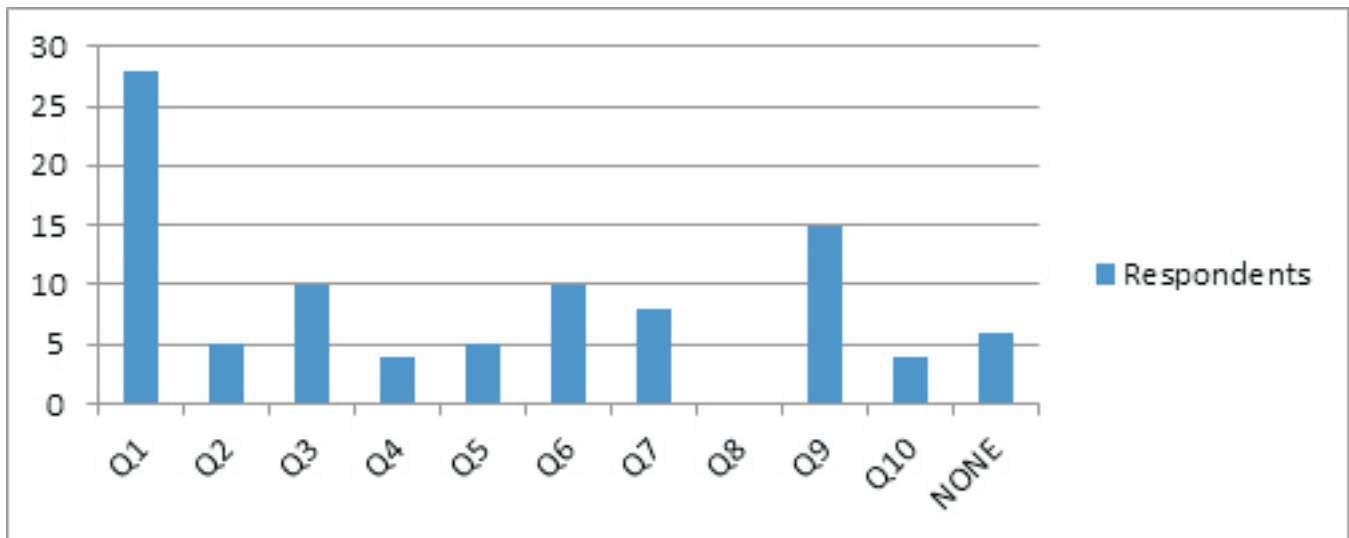


Fig12 Ranking the motivators.

Fig12 shows clearly that the strongest motivators are question 19 (section 2.1) followed by question 9 (section 2.9), follow by question 3 and 6 with an equal scores. On the other hand, the weakest motivators are question 8 (section 2.8) followed by question 4 (section 2.4), follow by question 2 and 5 with an equal score.

3. fostering students motivation.

Result of this case study show that our students are highly motivated by a competent teachers. However a major part of this motivation is due to extrinsic values. We therefore have to invest to redirect their motivation more towards intrinsic factors. It should be emphasized that effective students motivation can best be fostered by recognizing the need for a collective and collaborative effort of the major stake holders-administrators, parents, teachers and students.

This section collects common strategies found in literature that educators can exploit and create, nurture and sustain the motivation of their students for successful academic experience.

- Instructor enthusiasm and energy: An instructor enthusiasm is a crucial factor

in students motivation. When an instructor is bored or apathetic, students tend to become bored and de-motivated. In addition, being energetic in your teaching is a motivating factor in itself. Adding energy to ideas you want to convey will further enhance learning and commitment to the ideas. Instructors should positive emotion to make impressions on certain concepts and make those concepts memorable. Enthusiastic instructors would be creative in creating emotions. For example by doing something unexpected or even outrageous in order to create excitement for learning. Such activities make students learn readily and the learning will last much longer.

- De-emphasizing grades: Researchers recommend de-emphasizing grading by eliminating complex systems of credits point. They also advice against trying to use grades to control nonacademic behavior (for example lowering grades for missed classes), (Mohammed, L. & Waheed H. 2011): Instead we should

emphasize mastery and learning rather than grades. This can be achieved, for example, by assigning ungraded work and assisting students to complete such tasks through continuous feedback. Students would see their mistakes as acceptable and something to learn from. Basing everything on grades, however tend to make some students give up rather than risk low evaluation of their abilities- risking their self worth.

- Active learning: One of the major keys to motivation is the active involvement of students both mentally and physically engaged in the lesson like helping the instructor to complete a task on the board. Such activities tend to boost students self esteem and consequently, increasing their motivation. On the other hand, passivity dampens students motivation and curiosity.
- Satisfying students needs: Attending to need satisfaction is a primary method of keeping students interested and happy. Students basic needs have been identified as survival, love, power, fun and freedom. Students needs for power and freedom could be as simple as allowing them choose among two or three things to do like choosing between writing on extra papers and taking the final exam. Many students have a need to have fun, for example by being noisy and becoming excited. Instructors should avoid suppressing such needs. They should instead design educational activities to fulfill these needs.
- Team work: Human being are gregarious in nature and like being around each other (Harris, 2011). We should promote team culture among

our students by designing more team assignments. We can exploit the benefits of teamwork, where weaker students will learn by having others help. And of course, since teaching someone something is the best way to learn, the students who teach each other will learn better than if they were learning alone. Such a cooperative environment will be especially useful to students who find competitive environment unpleasant or even demotivating.

- Caring environment: Educators should strive to create a caring and supportive environment where students feel valued and respected, and where learning is expected, respected and recognized. In addition to being excellent teachers, instructors should be active socialization agent (Brophy, J. 2015) in order to stimulate students motivation to learn. Instructors should be approachable personally. They should care about students concerns and goals like asking what students like most and what their future academic plans are.
- Contextualizing learning : Helping students see how skills can be applied in the real world (lepper, M. R. 2000). Verbally noting the purposes of specific tasks when introducing them to students is also beneficial (Brophy, J. 2009). Instructors should spend more time explaining why they teach what they teach and why the topic or approach or activities is important, interesting and worthwhile.
- Goal setting : Teachers should help students define tasks in terms of specific, short term goals in order to assist students to associate effort with success (Stipek, D. 2012). In other

words, breaking learning content into small packages that can be conquered and that will in some way produce a feeling of accomplishment and success will help motivate students to go forward, even through very difficult material. Doing so prevents students from becoming overwhelmed and discouraged by lengthy projects. Failure to attain unrealistic goals can disappoint and frustrate students. With careful plan, instructors can give achievable but challenging tasks to students to stimulate their curiosity and hence, motivation.

4. Summary and Conclusion.

This paper presented the result of a case study on value and attitudes that affect students learning experience at FCE Zaria. About 200 NCE students of the college,(School of Secondary Education (Science) were surveyed for their opinions on the motivational values in a questionnaire of twelve questions. The results show that the strongest motivators are quality of teaching. Love of learning for its own sake (intrinsic motivation), values of good grades toward job prospects. The lowest motivators were peer respect, competition with peers in the same course and uncaring instructors attitude. In conclusion, the paper provided some strategies for enhancing student motivation.

5. Suggestion for further research.

The study is limited to students in FCE Zaria in Kaduna state. However, the perception, understanding and performance of mathematics could be different in other geopolitical region. The study suggest that similar research to be done in all tertiary institution in other geopolitical in the country so as to have comprehensive report on influence of students attitude on mathematics performances in tertiary institution.

The study was only limited to students.

However the views of the teachers who play a very crucial role in the teaching of mathematics were left out. There is need to carry out similar study involving the teachers in order to incorporate their views so as to have a comprehensive report.

The study made use of only one instrument for data collection the use of more than one method could be appropriate so as to compare the data, verify the results and to generate a conclusive and better report.

Declaration.

(1) Availability of data: This paper presented the result of a case study on value and attitudes that affect students learning experience at FCE Zaria. About 200 NCE students of the college,(School of Secondary Education (Science) were surveyed for their opinions on the motivational values in a questionnaire of twelve questions. The results show that the strongest motivators are quality of teaching. Love of learning for its own sake (intrinsic motivation), values of good grades toward job prospects. The lowest motivators were peer respect, competition with peers in the same course and uncaring instructors attitude. In conclusion, the paper provided some strategies for enhancing student motivation.

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Appendix: Questionnaire

Factors that affect my interest in Mathematics in FCE Zaria	Strongly Agree	Agree	Disagree	Strongly disagree
Q1 Quality of teaching by an instructor is the reason that make me like mathematics course and put more effort in it				
Q2 I easily lost interest in Mathematics, if the instructor does not show that he cares about students				
Q3. A major reason that makes me put extra effort in Mathematics is to get a good grade.				
Q4. I always want to do better than other students in my class. This is a strong reason that make me work harder in my course.				
Q5. I am always afraid of failure. This is why I work very hard in my course.				
Q6. I work hard to get good grades so that I can get good job with the help of my grades				
Q7. I put a lot of effort to get good grades to make my parent happy.				
Q8. My friends know me as a good students in mathematics so I work hard to maintain that.				
Q9. I have a strong interest in mathematics. This interest is the main push for me to work hard in mathematics.				
Q10. I'm only interested in the mathematics that I know I need later during my job experience.				
Q11. Other reasons that make you like or dislike mathematics.				
Q12. Which of the above factors affects your interest in studying mathematics most.?				

STRUCTURAL QUALITY ASSESSMENT OF THE VILLAGEMATH INSTRUCTIONAL CONTENT PLATFORM

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Abstract

This study presented outcomes of the structural quality assessment of the VillageMath educational intervention developed as a web-based ethnomathematics instructional content repository for Mathematics teachers in Benue State, Nigeria. The development was managed through WordPress Version 5.4, hosted online at <https://villagemath.net> on Linux OS server running with cPanel v80.p (Build 20), Apache Version 2.4.39, PHP Version 5.6.40 and MySQL Version 5.7.26. The study was guided by three research questions posed around quality assessment in terms of navigation, structure, and appearance of the designed web tool. The main instrument of the study is the researcher-developed Web-based Ethnomathematics Instructional Content Repository Assessment Questionnaire – WEICRAQ (Cronbach Alpha Coefficient = 0.98). The research questions were answered using mean and standard deviation. Analysis of the results of the study showed that pre-service and in-service mathematics teachers in Benue State, Nigeria unanimously rated the Web-based Ethnomathematics Instructional Content Repository high in terms of navigation, structure, and appearance. Based on the findings of the study, it was recommended that Mathematics teachers should continue to use the Web-based Ethnomathematics Instructional Content Repository as a worthy companion tailored to their specific professional needs, and that students across all levels of education should seek deeper and more enriched learning experience by continuously leveraging on instructional resources available on the web tool to enhance their individualized learning, enrich their cultural rediscovery, and add aesthetic value to their learning of Mathematics as a school subject. It was also recommended that Mathematics educators in colleges of education and universities should deploy the instructional environment as a veritable tool for re-directing narratives across the field of Mathematics Education, and that Non-governmental organizations (NGOs) and government agencies in the educational and cultural sectors should make use of the ethnomathematics platform to drive their initiatives in grassroots development.

Keywords: Mathematics Education, Instructional Design, Structural Quality Assessment, VillageMath, Ethnomathematics

INTRODUCTION

One of the ways digital technologies are aiding present day education is by serving as a vehicle for relaying instructional content. Specific areas of quantifiable success in this regard include ICT based instructional approaches, implementation of open and distance learning (ODL), online instructional repositories and circulation of open education resources (OERs) (Iji & Abah, 2018). Leading the pack in ODL, for instance, are the Massive Open Online Courses (MOOCs), designed for large number of participants, that can be accessed by anyone anywhere as long as they have an internet connection, are open to everyone without entry qualifications, and offer

full/complete course experience online for free (Home & OpenupEd, 2015). Online instructional repositories and OER platforms are a commonplace for enhancing conversation and collaboration in a mathematical community. In such online learning environment, diversity-bridging tools would include email, bulletin boards, forum, chat groups and conferencing (Holzl in Iji & Abah, 2018). The introduction of other new technologies like the virtual classroom and social media makes it possible to replicate technology-based mathematical experience within and outside the classroom (Hofmann, 2014), particularly via the development of web-based applications (or WebApp).

Design is a creative activity in which user requirements, business needs, and technical considerations all come together in the formulation of a high-quality product or system. WebApp design leads to products that contain the appropriate mix of aesthetics, content, and technology. Pressman (2005) notes that WebApp design encompasses six major steps that are driven by information obtained during analysis modeling, each contributing to the overall quality of the WebApp. The first step, interface design, describes the structure and organization of the user interface, including a representation of screen layout, a definition of the modes of interaction, and a description of navigation mechanisms. Aesthetic design, also called graphic design, describes the “look and feel” of the web-based tool, including colour schemes, geometric layout, text size, font and placement, the use of graphics, and related aesthetic decision. Content design defines layout, structure and outline for all content that is presented as part of the WebApp, establishing relationships between content objects. Navigation design represents the navigation flow between content objects and WebApp functions. Architecture design identifies the overall hypermedia structure for the web-based tool. The final step, component design, develops the detailed processing logic required to implement functional components within the web-based application. These activities are implemented within the key design goals of simplicity, consistency, identity, robustness, navigability, visual appeal and compatibility (Pressman, 2005).

Presently, there exist many mathematical content repositories on the World Wide Web (WWW), but only a few are solely dedicated to culture-based Mathematics education. Conventional Mathematics platforms such as Math.com, Mathplanet.com,

BasicMathematics.com, Mathplayground.com, SOSmath.com and Youcubed.org are built to encompass a wide range of content. Familiar contents hosted on these websites include blog articles, mathematical games, videos, teacher-guidelines, student-workbooks and mock tests. Additional services offered by these sites include Mathematics tutor service, specialized curriculum, consultancy services and marketing of educational products. The target audiences of these conventional Mathematics repositories are often teachers and students of Mathematics across different grades and educational levels. A few of these sites require users to register as either students or teachers so as to have full access to the functionality of the platform.

A culture-based Mathematics education repository is designed for the grounding of Mathematics instruction and student learning in the values, norms, knowledge, beliefs, practices, experiences and language that are the foundation of an indigenous culture. Based on cultural ways of being, knowing and doing, an ethnomathematics educational resources in its design take cognizance of the five key elements of language, family and community, context, content, and data and accountability (Kanaiaupuni, 2007). Such a tool recognizes and use native or heritage language, while actively involving family and community in its development, everyday learning and leadership. The context of presentation is structured in culturally-appropriate ways, making learning meaningful and relevant through culturally grounded content and assessment. The system must also gather and maintain data to ensure progress in culturally responsible ways.

Using the principles of culture-based Mathematics education, a few research efforts have reported blended technologies for learning in a local cultural context. Vainio, Walsh and Varsaluoma (2014) consider the impact of

culturally sensitive issues in the design of mobile Mathematics learning service in a longitudinal research with over thirty (30) South African schools across a three-year period. The platform designed as part of Nokia Mobile Mathematics deployed SMS-based applications, a mobile browser and a mobile social network, MXit, to deliver learning context including bookwork with content explanations, examples, exercises, homework questions and competitions. Within the project, teachers could use the exercise bank and theory for in-class teaching in follow-up, analyzing and monitoring how the pupils make progress. Overall, Vainio *et al.* (2014) found subjective and objective culturally dependent issues in the content, context, infrastructure and technology of the platform with the localization enhancing the user experience and supporting learning.

Similar attempt by Katmada, Mavridis and Tsiatsos (2014) focuses on the design, implementation and evaluation of online game for elementary and middle school Mathematics, with outcome redefining flexibility, adaptability and usability of web-based gaming tools. Relatedly, Govaerts, Cao, Faltin, Cherradi and Gillet (2015) provide reports on the development of the Go-Lab Tutoring Platform that offers teachers an online peer assistance and knowledge sharing environment, with the results of the prototype proving the concept as a promising solution to support teachers with bringing online labs into the classroom. Through the evaluation, the study investigated incentives to motivate teachers and tutors, providing an indication for a potential business model to involve diverse stakeholders, including ministries of education, teacher professional development organizations, teachers and STEM teacher community. Other instrumentation studies which sought to create learning environments for indigenous students

through culture-based Mathematics modules conclude that implementation through culture-based Mathematics instructional modules could motivate students' interest in learning Mathematics and enhance their initiatives in the classroom (Yao, 2016; Ofoegbu, Fayemiwo, Omisore, & Olarenwaju, 2014; Garmpis, 2011; Kartam & Al-Rashaid, 2002; Jung, Jun & Gruenwald, 2001).

Despite the prospects of culture-based instructional design and the enormous benefits accruable from optimal blends of culture and technology, there is a scarcity of research attempts on the ethnomathematical approach from within Nigeria. Phenomenal works such as Abah (2017), Iluno and Taylor (2013), Kurumeh, Onah and Mohammed (2012), and Yusuf, Saidu and Halliru (2010), though robust in the ethnomathematical sense, fell short of extending culture-based solutions to the cyberspace. Considering the fact that present-day students are a new genre of students with learning needs vastly different from their predecessors (Thomas, 2011) and live in a culture of learning, leisure and social interaction (Iji, Abah & Anyor, 2017), current research efforts need to explore the intricacies of using technology to give voice to indigenous knowledge systems in Mathematics education. Such research intervention in Mathematics education should basically prepare teachers to become innovative Mathematics instructors, professionally prepared to communicate Mathematics to learners at all levels (Iji, Abah & Anyor, 2018).

In the light of the promise of individualized learning available in a widely connected educational cloud, there is the need for a custom-made, web based product for Mathematics education practitioners in Benue State, Nigeria. Such a product must be designed with respect to the cultural foundations of Mathematics, with

particular reference to the indigenous people of Benue State, although future enhancement may encompass Nigeria, Africa and the world by the addition of components that will be multicultural and more diversified. These specific needs form the basis of this study around the development of a web-based ethnomathematics instructional content repository. This tool is intended to be a one-stop reservoir of online resources that are tailored to the peculiarities of Mathematics education as a field of practice in Benue State, Nigeria. The repository is intended to gather digital contents that are rooted in the culture of the different ethnic groups living in Benue State.

Specifically, the digital contents of such repository includes instructional articles, crowd-sourced blog articles, culture-based teaching approaches and lesson plans, instructional procedures for including local artifacts in Mathematics instruction, adaptations of local mathematical games, community based forums, social media and links to other Mathematics instructional platforms. The development of the online repository is to showcase the beauty of the Mathematics existing all around students and to draw attention of in-service and pre-service Mathematics teachers to pedagogies that effectively blend everyday Mathematics into classroom practice. The repository is targeted at making Mathematics more realistic, particularly, with reference to the cultural context of the subject in Benue State, North Central Nigeria.

With such a powerful tool in place, there is the concern of quality assessment. Quality in web-based tools, relates to customer satisfaction and also with the level of accomplishment of user expectation when interfacing a website. In this regard, quality captures perceptual aspects likely to be involved in human-website

interaction. These aspects focus on the affective and cognitive royalty of a site and are subjectively assessed by the user community. Such focus on quality maps to user satisfaction assessment and contributes to the emergence of website quality as an aggregate composite that brings together formal metrics and perceptual user traits (Moustakis, Litos, Dalivigas & Tsironis, 2004). By collecting various web analytics metrics, such as number of visits and visitors, and visit duration, one can develop Key Performance Indicators (KPIs) – a versatile analytic model that measures several metrics against each other to define visitor trends (Booth & Jansen, 2010). KPIs use these dynamic numbers to get an in-depth picture of visitor behaviour on a site, allowing web-based educational platforms to align their websites' goals with their intentions for the purpose of identifying areas of improvements, promoting popular parts of the site, testing new site functionality and ultimately making the desired impact.

Web quality is a complex concept, therefore its measurement is expected to be multi-dimensional in nature (Aladwani & Palvia, 2002). Scientific literature identifies several aspects or criteria of quality which are often aggregated to navigation, design and structure, and appearance and multimedia (Moustakis *et al.*, 2004). Content reflects quality, completeness, degree of specialization or generalization, and reliability of information included in the website. Navigation reflect the support provided to the user when moving in and around the site while structure and design incorporates aspects that affect order of presentation, speed and browser compatibility (Moustakis *et al.*, 2004). Appearance and multimedia captures aspects that relate to the site's "look and feel" with special emphasis in state of the art graphics and multimedia artefacts

(Lavie & Tractinsky, 2004, and Moustakis *et al.*, 2004).

It is against this background that this study embarks on the design, implementation and assessment of a web-based ethnomathematics instructional content repository for pre-service and in-service Mathematics teachers in Benue State, Nigeria. While seeking to draw attention of key stakeholders in the Mathematics education sub-sector to the Mathematics embedded in the culture, traditions and daily practices of the people of the Benue valley, this work reports the conception, development and growth of a web-based resource for all categories of practitioners in Mathematics teaching and learning. This effort entails inquiry into the perception of pre-service mathematics teachers and in-service mathematics teachers on the quality of the web-based ethnomathematics instructional content repository in terms of the five website quality assessment criteria of contents, navigation, structure and design, appearance and multimedia, and uniqueness.

RESEARCH QUESTIONS

The following questions guide this study.

1. To what extent do pre-service and in-service Mathematics teachers in Benue State rate the quality of the web-based ethnomathematics instructional content repository in terms of navigation?
2. To what extent do pre-service and in-service Mathematics teachers in Benue State rate the quality of the web-based ethnomathematics instructional content repository in terms of structure?
3. To what extent do pre-service and in-service Mathematics teachers in Benue State rate the quality of the web-based ethnomathematics instructional content repository in terms of appearance?

METHODOLOGY

The research design adopted for the study is developmental research design. This research blueprint is suitable for design-based researches, including studies of instructional design and development (Ritchey, Klein & Nelson, 2004). Developmental research is a process that integrates design and scientific methods to allow researchers to generate useful products and effective theory for solving individual and collective problems of education (Easterday, Lewis & Gerber, 2014).

The study was conducted in Benue State.

The population of the study is 2981 comprising pre-service mathematics teachers (mathematics education students) in universities and colleges of education in Benue State, Nigeria as well as in-service mathematics teachers at the Basic and Secondary Education levels across Benue State, Nigeria (Benue State Ministry of Education, Science and Technology, 2019, and Examination Office Records, 2019). This is made up of 2107 pre-service mathematics teachers and 874 in-service mathematics teachers.

The sample for the study is 341 pre-service and in-service mathematics teachers in Benue State, Nigeria. The sample size was arrived at by applying Krejcie and Morgan (1970) table for sample determination.

Purposive sampling was used for the study. Purposive sampling was used to select 241 pre-service mathematics teachers and 100 in-service mathematics teachers who have been duly registered as users on the *villagemath.net* platform. Purposive sampling was used because only pre-service and in-service mathematics teachers who have access to the internet and have used the web-based ethnomathematics instructional content repository can assess the quality of the platform.

The instrument for data collection in this study was the Web-based Ethnomathematics

Instructional Content Repository Assessment Questionnaire (WEICRAQ). The WEICRAQ is a user experience questionnaire adapted from a set of existing measures of website user experience including Measure of Perceived Visual Aesthetics of Websites (Lavie & Tractinsky, 2004), WebQual Measure of Website Quality (Loiacono, Watson & Goodhue, 2002), Multi-dimensional Scale for Measuring User-perceived Web Quality (Aladwani & Palvia, 2002), Measure of User's Perceived Portal Service Quality (Kuo, Lu, Huang & Wu, 2005), Standardized User Experience Percentile Rank Questionnaire – SUPR-Q (Sauro, 2015), and Scale to Measure the Interactivity of Web Sites (Liu, 2003).

The validation of the instrument for this study was done by two experts in Mathematics Education, two experts in Measurement and Evaluation, two pre-service mathematics teachers, two in-service mathematics teachers, two experts in Computer Science, one ICT expert, and a digital technology critic. The experts in Mathematics Education, Measurement and Evaluation, Computer Science and ICT are from Joseph Sarwuan Tarka University, Makurdi, Nigeria. The experts were requested to vet the instrument based on face validity, simplicity of language, and appropriateness of the constructed items in respect of the objectives of the study. Based on the recommendations of the experts, necessary modifications were made to the instrument. The validation yielded a total of 62 items after an initial effort of 70 items were subjected to thorough scrutiny.

To ensure reliability, the WEICRAQ was trial-tested on 50 users of the web-based ethnomathematics instructional content repository. The online platform for administering the WEICRAQ uses restrictive measures to prevent multiple submissions of

responses. On this basis, the 50 respondents used in the trial-testing are completely outside the sample for the study. Results obtained from the trial-testing were subjected to reliability analysis yielding a Cronbach's alpha coefficient of 0.98 for the entire WEICRAQ, indicating a high level of internal consistency of the instrument. Cronbach's alpha is considered a suitable measure of internal consistency of WEICRAQ because the items are structured on a four-point scale.

The WEICRAQ was administered to pre-service and in-service mathematics teachers in Benue State, Nigeria in online mode. The online survey uses a list-based frame of pre-service and in-service mathematics teachers in Benue State who have been verified as users on the villagemath.net platform. These users constitute a homogenous group for which a frame with phone numbers and email addresses has been assembled. The link to WEICRAQ was sent via SMS and/or email to the verified pre-service and in-service mathematics teachers. Email and phone contact information of respondents were provided voluntarily by villagemath.net users and were handled with utmost confidentiality.

The instrument is designed on JotForm and accessible via a link on the main menu of the villagemath.net platform. JotForm uses cookies, unique IPs and other security measures to implement restrictions and prevent duplicate submission of WEICRAQ. The choice of this mode of deployment hinges on the fact that the Web-based Ethnomathematics Instructional Content Repository is an online system that can only be assessed by respondents who have used the system and have been duly validated as belonging to the desired category of respondents. The online survey presented the items of WEICRAQ as a single, continuous and non-sectioned questionnaire to avoid fatigue due to section switching. All other metric tools

used in measuring the platform's behaviour and key performance indices are also hosted online by the respective service providers.

Data collected was analyzed using descriptive statistics. Research questions one to three were answered by the WEICRAQ and analyzed using mean and standard deviation.

RESULTS

The presentation of data analysis and

interpretation of results for this study was done according to the research questions.

Research Question One

To what extent do pre-service and in-service Mathematics teachers in Benue State rate the quality of the web-based ethnomathematics instructional content repository in terms of navigation?

Table 1: Mean Scores of Pre-Service and In-Service Mathematics Teachers' Rating of the Web-based Ethnomathematics Instructional Content Repository in terms of Navigation

S/NO.	Item	Pre-Service (N = 241)			In-Service (N = 100)			
		Mean	SD	Remark	Mean	SD	Remark	
1	Web pages on villagemath.net load fast.	3.35	0.78	High	3.58	0.69	High	
2	Mathematics teachers visiting the villagemath.net website are able to obtain the information they want without any delay.	3.15	0.68	High	3.41	0.77	High	
3*	The website villagemath.net is not available all the time.	3.29	0.88	High	2.95	1.12	High	
4	Links on the villagemath.net platform lead to instantaneous information.	3.28	0.66	High	3.34	0.69	High	
5*	Accessing information on villagemath.net is difficult.	3.34	0.74	High	3.02	0.95	High	
6	Information category on the website is simple and straightforward.	3.53	0.62	High	3.47	0.74	High	
7	The website has many interactive service features such as comments, contact, and forum that can be easily accessed.	3.23	0.78	High	3.51	0.64	High	
8	The villagemath.net website has adequate search facilities.	3.32	0.71	High	3.37	0.79	High	
9	The site exhibits easy orientation for different devices and browsers.	3.38	0.69	High	3.24	0.69	High	
10	Learning to operate the website is easy.	3.71	0.45	High	3.53	0.50	High	
11	Mathematics teachers are able to find what they need quickly on this website.	3.32	0.67	High	3.29	0.69	High	
12*	The layout available on villagemath.net makes it difficult to navigate the platform.	2.90	0.77	High	3.18	0.55	High	
13	Hyperlinks on the website are valid.	3.18	0.81	High	3.57	0.49	High	
		Cluster Mean	3.31	-	High	3.34	-	High

*Scoring for negative items are reverse-coded

The results in Table 1 indicate that pre-service and in-service mathematics teachers in Benue State rate the Web-based Ethnomathematics Instructional Content Repository high in terms of navigation, considering the high cluster mean of 3.31 and 3.34 for Pre-Service Teachers and In-Service Teachers respectively. Both means are above the benchmark of 2.50.

Research Question Two

To what extent do pre-service and in-service Mathematics teachers in Benue State rate the quality of the web-based ethnomathematics instructional content repository in terms of structure?

Table 2: Mean Scores of Pre-Service and In-Service Mathematics Teachers' Rating of the Web-based Ethnomathematics Instructional Content Repository in terms of Structure

S/NO.	Item	Pre-Service (N = 241)			In-Service (N = 100)		
		Mean	SD	Remark	Mean	SD	Remark
1	Services on villagemath.net is easy to locate.	3.30	0.72	High	3.32	0.69	High
2	The structure of the website shows originality in design.	3.57	0.49	High	3.62	0.48	High
3	The website has a fast loading speed.	3.46	0.52	High	3.60	0.58	High
4*	The site is not adaptable to all devices and screens.	2.75	0.95	High	2.40	1.03	Low
5	The villagemath.net website has a functional sitemap.	3.27	0.57	High	3.28	0.55	High
6	The website is compatible with different web browsers.	3.47	0.64	High	3.62	0.48	High
7	The site has a simple background schemes.	3.41	0.64	High	3.31	0.61	High
8	Information structure on villagemath.net reflects order and togetherness of information.	3.34	0.68	High	3.29	0.71	High
9	Visiting the site does not require any specialized software.	3.47	0.62	High	3.34	0.57	High
10	The villagemath.net site is responsive in providing information in real time conditions.	3.32	0.71	High	3.54	0.64	High
11	Links to share topics from villagemath.net to different social media platforms (such as twitter and facebook) makes the site desirable.	3.39	0.67	High	3.34	0.62	High

12	The availability of discussion forums on villagemath.net makes the platform professional for mathematics teachers.	3.42	0.60	High	3.65	0.47	High
13	The user authentication feature of villagemath.net provides additional security for mathematics teachers on the platform.	3.26	0.62	High	3.52	0.71	High
Cluster Mean		3.34	-	High	3.37	-	High

*Scoring for negative items are reverse-coded

The results shown in Table 2 indicate cluster means of 3.34 (Pre-Service Teachers) and 3.37 (In-Service Teachers) which are higher than the benchmark of 2.50. This implies that pre-service and in-service mathematics teachers in Benue State rate the Web-based Ethnomathematics Instructional Content Repository high in terms of structure.

Research Question Three

To what extent do pre-service and in-service Mathematics teachers in Benue State rate the quality of the web-based ethnomathematics instructional content repository in terms of appearance?

Table 3: Mean Scores of Pre-Service and In-Service Mathematics Teachers' Rating of the Web-based Ethnomathematics Instructional Content Repository in terms of Appearance

S/NO.	Item	Pre-Service (N = 241)			In-Service (N = 100)		
		Mean	SD	Remark	Mean	SD	Remark
1	Web pages on villagemath.net are visually attractive	3.34	0.61	High	3.47	0.59	High
2	The villagemath.net website looks organized.	3.34	0.62	High	3.44	0.63	High
3*	The website looks unattractive.	3.32	0.78	High	3.14	1.02	High
4	The website villagemath.net uses fonts properly.	2.97	0.77	High	3.05	0.81	High
5	The website uses colours properly.	3.07	0.59	High	3.12	0.71	High
6	The villagemath.net website uses multimedia features properly.	2.98	0.71	High	3.05	0.93	High
7	The appearance is gratifying with each visit to villagemath.net	3.11	0.65	High	3.02	0.82	High

8*	The display pages within the website are not easy to read.	3.10	0.93	High	2.93	0.77	High
9	The website labels are easy to understand.	3.05	0.78	High	3.49	0.64	High
10	The website has a clean and simple presentation.	3.20	0.57	High	3.62	0.63	High
11	The combination of image, voice and video on the site are appropriate.	3.24	0.64	High	3.48	0.50	High
12	The placement of graphics within articles on villagemath.net makes the articles more attractive for reading	3.43	0.64	High	3.67	0.61	High
Cluster Mean		3.18	-	High	3.29	-	High

*Scoring for negative items are reverse-coded

In Table 3, the result shows that pre-service and in-service mathematics teachers in Benue State rate the Web-based Ethnomathematics Instructional Content Repository high in terms of appearance, considering the high cluster means of 3.18 and 3.29 which are above the benchmark of 2.50.

DISCUSSION

Quality of the Web-based Ethnomathematics Instructional Content Repository in terms of Navigation

The analysis results in Table 1 indicate that pre-service and in-service mathematics teachers in Benue State rate the Web-based Ethnomathematics Instructional Content Repository high in terms of navigation. Navigation of web-based resources reflects the support provided to users when moving in and around the platform (Moustakis *et al.*, 2004). High quality of navigation implies fast loading web pages, responsive links, adaptability to different devices and browsers, adequate search facilities, and interactive layout. Unlike the challenges reported in a similar empirical work by Arroyo, Hornos and Montes (2007), the high rating given the Web-based Ethnomathematics Instructional Content Repository represents a generational leap in the capability of modern technologies used in the design of this repository. Also the present design deploys underlying technologies similar to those reported by Charles and Babatunde (2014), but without specific focus on course delivery, and real-time synchronous class activities. In contrast, the Web-based Ethnomathematics Instructional Content Repository is basically a resource hub and not a grading/studying for certification environment. Instructional activities for users, particularly pre-service and in-service mathematics teachers, are designed to be consumed in an asynchronous mode with all necessary provision for feedback and user support as attested to in Table 1. While on the platform, teachers are able to reflect upon their ideas before sharing them as threaded discussions, leading to more reflective responses and in-depth learning.

Quality of the Web-based Ethnomathematics Instructional Content Repository in terms of Structure

The results shown in Table 2 indicate a cluster means of 3.34 and 3.37 which are higher than the benchmark of 2.50, implying that pre-service and in-service mathematics teachers in Benue State rate the Web-based Ethnomathematics Instructional Content Repository high in terms of structure. The structure of a website refers to aspects that affect order of presentation, speed and browser compatibility (Moustakis *et al.*, 2004). Pre-service and in-service mathematics teachers affirms that the information structure of the repository reflects order and togetherness of information. Again, this design feature was made possible via WordPress' utilization of themes. The use of WordPress themes clearly distinguishes the designed platform from those reported by Grampis (2011), Kartain and Al-Reshaid (2002), and Jung, Jun and Gruenwald (2001).

Specifically, the availability of discussion forums on the Web-based Ethnomathematics Instructional Content Repository makes the platform structurally professional for mathematics teachers and educators. This professionalism is further aided by links for sharing topics from the platform to social media platforms such as WhatsApp, Telegram, Facebook, Twitter, and LinkedIn, since teachers and educators can extend their professional points of views to other stakeholders within the mathematics education sub-sector (Abah, Age & Okoronkwo, 2018).

The results in Table 3 holds serious positive implications for the platform's visibility on the Internet. Site structure is a vital aspect of Search Engine Optimization (SEO) strategy. The structure of the website shows search engines which pages of the site are most important. This means the site structure influences which articles will rank the highest. This finding agrees with Van de Rakt (2018) assertion that site structure

implies how the websites content is organized. The Web-based Ethnomathematics Instructional Content Repository consists of content of related topics, presented on posts and pages. The unique of the platforms handles how the content is grouped, linked and presented to the visitor. In this structure, users find their way more easily and search engines can index the platform's URLs. In addition, taxonomies like categories and tags, internal links and navigation toggles available on the platform all redirect traffic to the Web-based Ethnomathematics Instructional Content Repository.

Quality of the Web-based Ethnomathematics Instructional Content Repository in terms of Appearance

The result in Table 3 shows that pre-service and in-service mathematics teachers in Benue State rate the Web-based Ethnomathematics Instructional Content Repository high in terms of appearance. Appearance and multimedia captures aspects that relate to the platform's "look and feel" with special emphasis on state of the art graphics and multimedia artefacts (Lavie & Tractinsky, 2004; Moustakis *et al.*, 2004). The core users of the platform seek interactive multimedia elements that are used to represent culture-based concepts, abstractions, actions or simulations, metaphors and modifiers. They intend to integrate these learning objects available on the platform into complex arguments, in a creative and innovative fashion, as demanded by their specific learning aims outlined in the mathematics curriculum or being canvassed by the culture-based mathematics paradigm (Mondi, Woods & Rafi, 2007). Apart from this cognitive uses and gratification expectancy, pre-service and in-service mathematics teachers also seek affective uses and gratification expectancy in their quest for media experiences that evoke pleasure and emotional engagement and enhance their self-efficacy perception. Additionally, the results in

Table 3 alluded to high entertainment uses and gratification expectancy. The appearance quality of the repository adequately meets users' tendency to seek e-learning resources that are fun and exciting. The unique intrinsic properties of the resources available on the ethnomathematics platform appeal to users' imaginations and arouse their emotions, matching the users' idiosyncratic appraisal of these properties (Mondi, Woods & Rafi, 2007). The appearance value of the platform lies in the tendency of visitors to use multimedia to escape through attention, engagement, aesthetic enjoyment and tension release. This also meets users' expectation that the Web-based Ethnomathematics Instructional Content Repository afford the entertainment, compelling and engaging lesson contents and tasks in form of visual models, multimedia presentations, simulations and indigenous games.

The development of the Web-based Ethnomathematics Instructional Content Repository gave special attention to site appearance because of its impact on user engagement. The Kontrast theme that controlled much of this appearance was selected after trying several others within the framework of the Cleanroom Software Engineering Model (Miles, Dyer & Linger, 1987). The theme creatively optimized the site's appearance as can be gleaned from the outcomes reported in Table 4 and the high average page per visitor arrived at for the system. The strategies resulting in these positive outcomes are evidence-based, building on recommendations such as that of Dahal (2011) which underscore that it takes a very short time for users to form an opinion about a website that determines whether they will stay or leave. It was, thus, essential to make the web design of the instructional platform simple and familiar. Users have expectations of what an educational website should look like. Diverting from those is a risk, no matter how imaginative or striking the design (Laja, 2019).

CONCLUSION

Analysis of results obtained from the web performance assessment tools indicated that the Web-based Ethnomathematics Instructional Content Repository appeals to a wide range of highly engaged users. The user experience data obtained via the WEICRAQ showed that pre-service and in-service mathematics teachers in Benue State, Nigeria rated the Web-based Ethnomathematics Instructional Content Repository high in terms of navigation, structure, and appearance. Both categories of mathematics teachers unanimously rated the platform high in terms of navigation, structure, and appearance. These findings indicated that the designed innovation has the potential to aid Mathematics teachers in providing the necessary guided-re-invention of the mathematics classroom along the culture-based continuum.

RECOMMENDATIONS

The following recommendations are made based on the findings of this study:

- i. Students across all levels of education should seek deeper and more enriched learning experience by continuously leveraging on instructional resources available on the Web-based Ethnomathematics Instructional Content Repository to enhance their individualized learning, enrich their cultural rediscovery, and add aesthetic value to their learning of Mathematics as a school subject.
- ii. Mathematics teachers, both in-service and pre-service, should continue to use the Web-based Ethnomathematics Instructional Content Repository as a worthy companion tailored to their specific professional needs. The platform holds numerous templates for adaptable classroom activities that teacher can access to drive vital conversations in culture-based Mathematics education. The platform's discussion forum available at <https://ngsme.villagemath.net> is a network of

experts and enthusiasts from all over the globe meant to keep Mathematics teachers abreast of international best practices within the discipline.

iii. Mathematics educators in colleges of education and universities should deploy the Web-based Ethnomathematics Instructional Content Repository as a veritable tool for re-directing narratives across the field of Mathematics Education. Scholars of Mathematics Education from within and outside Nigeria should freely use the platform to communicate their development of state-of-the-art pedagogies for the field.

iv. Non-governmental organizations (NGOs) and government agencies in the educational and cultural sectors should make use of the ethnomathematics platform to drive their initiatives in grassroots development. The Web-based Ethnomathematics Instructional Content Repository is open to NGOs like United Nations Education, Scientific and Cultural Organization (UNESCO), International Cultural Youth Exchange (ICYE), Foundation for African Cultural Heritage (FACH), Tender Arts Nigeria (TAN), and government agencies such as Nigerian Tourism Development Corporation (NTDC) and National Council for Arts and Culture (NCAC) as a channel for posting socio-cultural messages to the dedicated followership of the VillageMath Network. Ethnomathematics research-based organizations within and outside Nigeria can also showcase their indigenous knowledge systems via forums hosted on the Web-based Ethnomathematics Instructional Content Repository.

v. Educational policy makers such as the Nigerian Education Research and Development Council (NERDC) should ride on the popularity of the Web-based Ethnomathematics Instructional Content Repository to spur the inclusion of relevant cultural artefacts and indigenous games in the development of the Mathematics curriculum for Basic and Secondary Education. Other establishments like National Universities Commission (NUC), National Council for Colleges of Education (NCCE) and the Mathematical Association of Nigeria (MAN) should consider the progress tracked by this study as wake-up call to re-structure their Benchmark Minimum Academic Standards (BMAS), curricula, and re-training activities around culture-based mathematics education.

vi. Government at the Local, State and Federal levels should ride on the outcomes of this study to maximize the wealth derivable from the cultural diversity of the peoples and cultures of Nigeria. The under-utilized heritage sites across the country can be revived to their full potential by linking to their associated mathematical dimensions. Relevant agencies of government should organize cultural expeditions to these cultural sites, artefacts, and festivals to revamp indigenous knowledge systems, rebuild cultural and moral values in the citizenry, and generate more income. The Web-based Ethnomathematics Instructional Content Repository is open to all collaborations in this regard.

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**INVESTIGATION OF CONTENT COVERAGE OF SECONDARY SCHOOL
MATHEMATICS CURRICULUM ON STUDENTS' PERFORMANCE AT SENIOR
SECONDARY CERTIFICATE EXAMINATION (SSCE) IN LERE EDUCATION ZONE
KADUNA STATE, NIGERIA.**

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Abstract

This study Investigates the level of Content Coverage of Secondary School Mathematics Curriculum on Students Performance at Senior Secondary Certificate Examination (SSCE) in Lere Education Zone of Kaduna State, Nigeria. Sample of thirty teachers were drawn out of the population of forty four teachers from forty four public secondary schools across the education zone. Two objectives, two research questions and two null hypotheses were formulated to guide the conduct of the study. Null hypotheses were tested using frequency counts and simple percentages. The result of the study reveals that significant topics were not taught sufficiently, it is also observed that teacher qualification and years of teaching experience has influence on the level of coverage of topics in the secondary school mathematic curriculum. It is therefore recommended that mathematics teachers should create more time for extension classes in preparation for examination with emphasis on understanding and coverage of topics as well. Teachers should endeavor to teach all observed skipped topics irrespective of whether examination questions are set on such topics or not.

INTRODUCTION

Mathematics is seen by the society as the foundation of scientific and technological knowledge, which is vital in the socio-economic development of a nation. Mathematics played an important role in the development of society from prehistoric to the present (Makarfi, 2001). Therefore, understanding and performance of mathematics has become a matter of concern to all stakeholders in education. Mathematics is an extensive field that has been variously defined from different perspectives. However, all these definitions converged to the same meaning hence, mathematics means the study of numbers, shapes equality, inequality, symbols, measurement, relationship and so on (Aminu, 2016). It is observed that, mathematics occupies a unique position in the whole aspect of human life and to education in particular at different levels. For this reason therefore, the knowledge of the subject of mathematics cannot be overemphasized.

The declining academic achievement in the subject is an unhealthy trend which most not be

allowed to go unchecked as no nation can develop without a good number of its populace well-grounded in mathematics knowledge. Looking at the importance of mathematics to human life and to scientific development in particular, effort has to be made to eradicate the learning difficulties of students in mathematics and hence improve the basic mathematics skills to be acquired at all levels of education.

A number of studies have reported the downward trend in the performance of Nigerian students in science at the Senior Secondary Certificate Examination (SSCE) among them mathematics is one (Ajagun, 2001). This rate of failure at SSCE has continued to be a matter of concern to all stake holders in education. A lot of reasons have been identified to be responsible for the high rate of failure, prominent among them are; teachers use of inappropriate methods of teaching, overloaded mathematics syllabus, difficulty of topics and some concepts as well as absence of dedication and resourcefulness on the part of the teachers as indentified by (Lawal, 2010). Poor teaching approaches and methods

(Harbor-Peter, 2002), Lack of qualified mathematics teachers (Agwagah, 2001), Students lack of interest/negative attitude toward mathematics, poor instructional techniques employed by teacher among others. Aprebo (2000) asserted that; teachers sometimes leave the class without completing the day's topic. The teachers' level of non coverage of mathematics topics would be affected by the amount of time lost as a result of unscheduled school closure; Location of school could also contribute to non coverage of mathematics content. It is observed that, teachers and students are frequently absence from classes during market days and rainy season due to certain reasons.

Disappointedly, students' performance in mathematics does not commensurate with resources and expectations placed on the subject. It has been noted that even with technology, students' performance in mathematics has not improved significantly despite the importance of mathematics (Olaleka (2014). Obi, (2014) noted that students' performance in mathematics does not match the acknowledge importance of mathematics. Wale, 2015 reveals that there were still indication of failure in the WASSCE conducted by the West African Examination Council in the year 2013, 2014 and 2015 result. More so, analysis of the West African Senior Secondary School Certificate Examination (SSCE) from the year 1991 to 2016 revealed that apart from the year 2004, in which 53.80% students obtained credit and above in mathematics, the percentage of students that obtained credit and above has always been below 50%. The average percentage of students that obtained credit and above in mathematics was noted to be 27.31% (Zalmon & Wonu, 2017).

This is an indication that; despite the importance placed on mathematics, massive and consistent failures of students in the subject have remained a major threat to its learning. Statistic show that mass failure in mathematics is real and the trend

of student's performance has been on the decline. This was further stressed by the stated topics published by the West African Examination Council and Senior Secondary School Certificate Examination (SSCE) 2015, which showed that between 2008 to 2014 less than 40 % of Nigerian students were able to obtain a credit in each of these years in mathematics at their senior secondary examination. Also, the chief examiners for mathematics (core) 2 and mathematics (elective) 2 pointed out that the performance in 2017 was not encouraging. However, that of mathematics (core) 2 was slightly better than 2016.

Mathematics curriculum in Nigeria can be seen as document prepared by Nigerian Education Research and Development Council (NERDC) which contains mathematical contents and guidelines for teaching and learning of the subject throughout the school in the federation. Mathematics curriculum in an industrialized society has been perceived as; a construct around which hopeful and useful knowledge and skills are developed through learning conducted in school settings (Woolcott, 2013). The present senior secondary school mathematics curriculum according to NERDC (2007) pay attention to the achievement of the Millennium Development Goals (MDGs) and critical element of the National Economic Empowerment and Development Strategies (NEEDs).

Statement of the Problem

Despite the vital roles played by mathematics in scientific and technological development of the nation, its teaching and learning are faced with some problems that make most students to perform poorly in the subject. This might have resulted from a number of factors among them the lack of content coverage might be one. Evidence from researches shows the persistent failure of students in the Senior Secondary Certificate Examination (SSCE). Akinsolu

(2010) observed that teachers are vital pre-requisites for students' attainment of educational goals and objectives. Similarly, Ashimole (2011) emphasized that teaching and learning depends largely on teacher, and that it is on teachers' number, quality and devotion that rest the effectiveness of all educational arrangements, development and growth. The teacher is ultimately responsible for translating educational policies and principles into actions based on practice during interaction with the students. This is because no education can go beyond the quality of its teacher. This observation becomes a challenge and this is why the current effort is being embarked upon to verify the claim. Therefore, the need to investigate on the level of Content Coverage of Secondary School Mathematics Curriculum on Student Performance at Senior Secondary Certificate Examination (SSCE) in Lere Education Zone Kaduna State, Nigeria cannot be overemphasize.

Objectives of the Study

The purpose of this study was to investigate the level of Content Coverage of Secondary School Mathematics Curriculum on Students Performance at Senior Secondary Certificate Examination (SSCE) in Lere Education Zone Kaduna State, Nigeria. The study aimed to determine the uncovered area(s) in the Secondary School Mathematics Curriculum. Specifically, the study aimed to;

1. Discover if there exist any area(s) in the Secondary School Mathematics Curriculum where Mathematics Teachers usually left behind.
2. Discover if there exist any area(s) in the Secondary School Mathematics Curriculum where Mathematics Teachers need further training before they can competently teach the topics.

Research Questions

The following research questions were asked to guide the conduct of the study;

1. Is there any area(s) in the Secondary School Mathematics Curriculum where Mathematics Teachers usually left behind?
2. Is there any area(s) in the Secondary School Mathematics Curriculum where Mathematics teachers need further training before they can competently teach the topics?

Null Hypotheses

The following null hypotheses were formulated to guide the study;

1. There is no significant area(s) in the Secondary School Mathematics Curriculum where Mathematics Teachers usually left behind.
2. There is no significant (area) in the Secondary School Mathematics Curriculum where Mathematics teachers need further training before they can competently teach the topics.

Methodology

The research design used for this study was a descriptive survey. Data were collected from the selected sample of the study.

The population of this study comprises of thirty four (34) teachers across thirty four public secondary schools in the research area, among them eleven (11) teachers teaches at junior secondary section while twenty three (23) teachers teaches at senior secondary section. Thirty out of the teachers are males while four teachers are females.

Table 1: Distribution of the Population of the Study

S/N	NAME OF SCHOOLS	NUMBER MALE	OF FEMALE	TEACHERS TOTAL
1.	GSS R/Kura	2	-	2
2.	GSS D/ Alhaji	1	-	1
3.	GSS Lere	1	-	1
4.	GSS Isheme	1	-	1
5.	GSS D/Lere	1	-	1
6.	GSS G/Mariri	1	-	1
7.	GSS Maskawa	1	-	1
8.	GSS Federe	1	-	1
9.	GSS Saminaka	2	1	3
10.	GSS Garun Kurama	1	-	1
11.	GSS U/Bawa	1	-	1
12.	GSS Warsa Piti	1	-	1
13.	GSS D/lagga	1	-	1
14.	GSS Kayarda	2	-	2
15.	GSS Yarkasuwa	2	-	2
16.	GSS Maigamo	1	-	1
17.	GSS Gure	1	-	1
18.	GSS Kahugu	-	-	-
19.	Government College Saminaka	2	-	2
20.	GJSS B/Kahugu	1	-	1
21.	GJSS Y/Kasuwa	1	-	1
22.	GJSS Lere	1	-	1
23.	GJSS Krosha	1	-	1
24.	GJSS Garun Kurama	-	1	1
25.	GJSS Saminaka	1	-	1
26.	GJSS R/Kura	1	-	1
27.	GJSS Gure	-	-	-
28.	GJSS Kayarda	1	-	1
29.	GJSS U/Shawara	-	-	-
30.	GJSS Jingir	-	-	-
31.	GJSS Ukissa	-	-	-
32.	GJSS K/Domawa	-	-	-
33.	GJSS Kudaru	-	1	1
34.	GJSS Udammi	-	1	1
	TOTAL	30	4	34

Source: Lere Education Zone (2021).

Table 1 show the distribution of population of the study comprising of thirty four public secondary schools across Lere Education Zone of Kaduna State. The researcher intended to use the whole population as sample since the target population can be reached.

The sample of this study consists of thirty (30) teachers, among them twelve (12) teachers teaches at junior secondary section, fourteen (14) teachers teaches at senior secondary section and four (4) teachers teaches at both junior and senior secondary school sections.

Table 2: Distribution of Sample of the Study

S/N	NAME OF SCHOOLS	NUMBER OF TEACHERS		TOTAL
		MALE	FEMALE	
1.	GSS R/Kura	2	-	2
2.	GSS Isheme	1	-	1
3.	GSS D/Lere	1	-	1
4.	GSS Garun Kurama	1	-	1
5.	GSS Saminaka	1	1	2
6.	GSS Kayarda	1	-	1
7.	GSS Yarkasuwa	1	-	1
8.	GSS Gure	1	-	1
9.	GSS Kizakoro	1	-	1
10.	GSS Kono	1	-	1
11.	GSS Gurza-Mariri	1	-	1
12.	GSS Geshere	1	-	1
13.	GSS Federe	1	-	1
14.	GSS Lere	1	-	1
15.	GSS U/Bawa	1	-	1
16.	GSS Kuduru	-	1	1
17.	GTC Saminaka	1	-	1
18.	GJSS Garun Kurama	-	1	1
19.	GJSS Udammi	1	-	1
20.	GJSS Krosha	1	-	1
21.	GJSS Lere	1	-	1
22.	GJSS Saminaka	1	-	1
23.	GJSS Y/Kasuwa	1	-	1
24.	GJSS Dan-Alhaji	1	-	1
25.	GJSS D/Lere	1	-	1
26.	GTC Saminaka	1	-	1
27.	GJSS D/Lagga	1	-	1
28.	GJSS K/Domawa	1	-	1
	Total	27	3	30

A questionnaire named; mathematics concept teachers questionnaire (MCTQ) of two types each with two sections; first type was junior secondary mathematics teachers questionnaire (JSSTQ) with two sections; the first section of each consisted of demographic data of the respondents such as teachers qualification, years of teaching experience, the second section consisted of thirty three (33) items drawn from junior secondary mathematics curriculum for the teachers to tick those topics they usually left behind. The second type was senior secondary mathematics teachers' questionnaire (SSSTQ)

with four (40) items drawn from senior secondary school mathematics curriculum were used for data collection. The instruments were validated by three experts on the rank of senior lecturer and above, two from Department of Science Education A.B.U, Zaria and one from Department of Mathematics, Federal College of Education, Zaria. Their corrections were noted and incorporated. The reliability of the instruments was tested using test re-test reliability and was found to be 0.63. The administration and collection of the questionnaire was done by the researcher with

the help of heads of the schools. Some of the questionnaires were distributed and collected immediately while some were collected later through the principals of the schools. Twenty five (25) questionnaires were distributed for senior secondary mathematics teachers while fourteen (14) were returned and fifteen (15) questionnaires were distributed for junior secondary mathematics teachers and twelve (12) were returned also four (4) questionnaires were returned for those teachers who teach both junior and senior secondary sections. This gives the total of thirty (30) returned questionnaires for both junior and senior sections which were sorted based on identical opinions of the respondents for easy tabulation. For analyzing the questionnaires, the researcher made not covered and almost covered as not covered, not

necessary and not quite necessary as not necessary.

For analyzing the hypotheses, the raw data collected through the method of research instrument was processed and prepared for presentation as tabulated evidences. The technique used in constructing these tables include; frequency and percentage calculations. Thus, all the conclusions about the findings of this study were made on the bases of percentage of the responses recorded. The tables were prepared to serve as the main frame-work around which the analyses, conclusions and recommendations were made.

Result

Based on the findings from the study, the following results were made;

Table 3: Number and percentage of teachers rated themselves as those who usually cover the scheme of work and those who usually don't cover at junior secondary section.

S/N	Number of Yes, covered	Percentage (%) of Yes covered	Number of No, not covered	Percentage (%) of No, not covered
1.	1	6.25	0	0.00
2.	0	0.00	1	6.25
3.	0	0.00	1	6.25
4.	0	0.00	1	6.25
5.	0	0.00	1	6.25
6.	0	0.00	1	6.25
7.	0	0.00	1	6.25
8.	0	0.00	1	6.25
9.	0	0.00	1	6.25
10.	0	0.00	1	6.25
11.	1	6.25	0	0.00
12.	0	0.00	1	6.25
13.	0	0.00	1	6.25
14.	0	0.00	1	6.25
15.	0	0.00	1	6.25
16.	0	0.00	1	6.25

The result from table 3 shows that 87.5% i.e (fourteen out of sixteen) teachers do not usually cover their scheme of work at junior secondary school section, only 12.5 % i.e (two out of sixteen) teacher usually cover their scheme of work. Their reasons among others are; too much content of the syllabus compared to the time schedule, too much work load by a teacher, some of the topics are too wide and difficult so consume much time, slow assimilation in the part of the learners and public holidays.

Table 4: Number and percentage of teachers rated themselves as those who usually cover the scheme of work and those who usually don't cover at senior secondary section.

S/N	Number of Yes, covered	Percentage (%) of Yes covered	Number of No, not covered	Percentage (%) of No, not covered
1.	0	0.00	1	5.56
2.	0	0.00	1	5.56
3.	0	0.00	1	5.56
4.	0	0.00	1	5.56
5.	1	5.56	0	0.00
6.	0	0.00	1	5.56
7.	0	0.00	1	5.56
8.	0	0.00	1	5.56
9.	0	0.00	1	5.56
10.	0	0.00	1	5.56
11.	0	0.00	1	5.56
12.	0	0.00	1	5.56
13.	0	0.00	1	5.56
14.	0	0.00	1	5.56
15.	1	5.56	0	0.00
16.	0	0.00	1	5.56
17.	0	0.00	1	5.56
18.	0	0.00	1	5.56

It can be observed from table 3 that; about 88.9 % of the teachers i.e (sixteen out of eighteen) teachers usually don't cover their syllabus. Only 11.1 % of the teachers' i.e (two out of eighteen) teachers usually cover their syllabus. Their reasons for not covering ranges from; Slow understanding of students and lack of enough time, slow assimilation from the students and interruption by other school official responsibility, Interruptions such as public holidays, Taking too much time to explain due to students' level of understanding, language barrier, poor mathematics foundation, some of the topics are wide and need to be thought in two to three weeks, inadequate parental support, slow level of comprehension by the majority of the learners, late resumption in the part of the learners and too many classes handled by one teacher.

Discussion of Results

The finding from this study reveals that; about 88% of the teachers usually don't cover their syllabus at both junior and senior secondary school sections. This is in line with the findings of Ekue, N. I and Umukoro P (2016). who assess the level of coverage of topics in senior school mathematics curriculum by teachers in delta state senatorial districts. At junior secondary school section, the topics which are usually left behind are; Measure of central tendency, Probability, Scale drawing, Proportion, Trigonometric functions, Geometric construction, Simultaneous linear equation, Number base, Statistics, Plane figures, Quantitative reasoning and Logarithm table. At senior secondary school section, the topics which are usually left behind are; Logical reasoning, Modular arithmetic, Sets, Simple equation and variations, Gradient of a curve, Circle theorem, Bearing, Cumulative frequency

graph and Application of linear and quadratic to capital market. These topics are similar to those topics where the teachers rate themselves as the areas where they need further training before they can teach competently. Though some of the teachers indicate those topics which usually come last in the syllabus as those topics they do not usually cover due to lack of enough time. Thus teachers require further training before they can teach these topics competently.

Conclusions

Based on the findings from this study, the researcher concluded that;

1. Poor performance among secondary school students may be as a result of uncovered areas and difficult topics faced by mathematic teachers in Lere Education zone of Kaduna State, Nigeria.
2. There are significant areas in the secondary school mathematics curriculum where mathematics teachers usually don't cover and also significant areas where the teachers require further training before they can adequately teach the topics.
3. There is a clear manifestation of the indication that the lack of content coverage has a great contribution on the poor performance of the students at SSCE.
4. There are significant areas in the secondary school mathematics curriculum where mathematics teachers require further training before they can adequately teach the topics.
5. It is hope that the findings from this study is the same in the hole secondary school in Lere Education Zone of Kaduna State, though the finds reveals a significant effect of lack of content

coverage on the performance of students at SSCE, the data set is small for generalization, thus, a wider investigation need to be carried out by other researchers.

Recommendations

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

1. Kaduna state government should employ sufficient qualified mathematics teachers in secondary schools so as to reduce the work load taking by the available teachers in order to achieve the educational set objectives effectively and to meet the nation technological changing environment.
2. Mathematics teachers should create more time for extension classes in preparation for examination with emphasis on understanding and covering topics as well. Teachers should also endeavor to teach all observed skipped topics irrespective of whether examination questions are set on such topics or not.
3. Regular workshops and seminar should be organized either by ministry of education or relevant governmental and non-governmental organizations to address identified frequent uncovered and difficult areas where the teachers usually don't cover or felt incompetent to teach.
4. Finally, it is advised that; re-fresher training should be organized by the state ministry of education on regular bases as the content of mathematics is dynamic in order to improve the level of effectiveness of the achievement of the stated objectives of the content.

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EFFECT OF PROJECT-BASED TEACHING METHOD ON STUDENTS' PERFORMANCE IN ALGEBRAIC EQUATIONS IN SOKOTO STATE, NIGERIA

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Abstract

The study compares project-based method of teaching with traditional method of teaching on students' performance in Algebraic Equations. The study was carried out in response to the growing decline in the performance of students in Mathematics, especially in external examinations such as the West African Examination Council (WAEC), National Examination Council (NECO) as well as National Business and Technical Examination Board (NABTEB). Two objectives, research questions and null hypotheses guided the study. The targeted population of the study was sixteen thousand nine hundred and seventy-nine (N =16,979) Senior Secondary School Students from the six Educational Zones of Sokoto state – Nigeria. Purposive sampling was used to draw the sample of two hundred and fifty (S =250) students. Quasi experimental research design was used involving non-randomised selection of subjects. The instrument used in data collection was Algebraic Equations Performance Test (AEPT). The reliability index of the instrument was found to be 0.92 obtained using split half method of establishing reliability. At descriptive level, findings of the study revealed that the mean performance of students taught Algebraic Equations using PBM of teaching is greater than those taught using traditional method of teaching. At inferential level, findings revealed that there is a significant difference in the performance of students taught using project-based method than those taught using traditional method because the calculated t-values were found to be greater than the critical value if t at 0.05 level of significance. Similarly, the findings also indicated that there is significant gender difference in the performance of students, in which male students were found to perform significantly better than female students. The study recommended amongst other things, the need for adopting project-based method of teaching as an alternative to traditional method in teaching Mathematics.

Keywords: Project-based teaching, Traditional teaching, Mathematics, Algebra, Performance

Introduction

Mathematics is a communication system in science, art and business world. Odogwu, (2008) points out that it is used in describing diverse phenomena in both physical and economic situations. It is a science of number and size concerned with logical deduction from general premises of all reasoning (Chalmers, 2013; Husserl, 2012; Jaynes, 2003), with a wide application in life (Verschaffel, Greer & DeCorte, 2000; Blum & Niss, 1991). Similarly, the role of Mathematics in the development of science, technology and even art and humanities is highly indispensable (Ahlberg, Nilson & Walsh, 2016; King, 2006; Davis & Hersh, 2005; Kalantari, 2004). Therefore, its skills, knowledge and application help individuals, organizations and even nations to solve their

immediate problems. Despite the great emphasis placed on the study of Mathematics, one area lacking serious attention in its teaching is Quadratic Equation (Ellerton & Clements, 2011; Huan & Kulm, 2012). It can be deduced that all is not well with the teaching and learning of the subject matter of quadratic equation as an offshoot of algebra (Schoenfeld, 2016; Ball, 2000; Kaput, 2000; Carpenter, Franke & Levi, 2003).

In mathematics, quadratic equation is defined as an equation of degree 2, meaning that the highest exponent of this function is 2. The standard form of a quadratic is $y = ax^2 + bx + c$, where a, b, and c are numbers and a, cannot be equal to 0. In algebra, a quadratic equation (from the Latin quadratus for "square") is any equation having the form where x represents an unknown, and a,

b , and c represent known numbers such that a is not equal to 0. If $a = 0$, then the equation is linear, not quadratic. The numbers a , b , and c are the coefficients of the equation, and may be distinguished by calling them, respectively, the quadratic coefficient, the linear coefficient and the constant or free term.

Researchers (Asikhia, 2010; Maliki, Ngban & Ibu, 2009; Tella, 2007) are unanimous on the overwhelming evidence of poor performance of students in Mathematics at all levels of the education system. Annual Reports of WAEC of 2016, 2017, and 2018 revealed a disheartening and alarming poor secondary school students' performance in Mathematics. Summary of the report shows that only 29.5%, 38.92% and 34.03% of the total enrolment in Mathematics for the respective years were able to make up to credit passes in the Senior School Certificate Examination (SSCE). The remaining percentages of 70.50, 61.08 and 65.97 respectively, obtained ordinary passes and failing grades. Against the backdrop of these indices recorded, Tella (2010) says the primary reason for this poor performance was partly motivation and pedagogical incompetence. Thus, he advocated for adequate motivation from all the stakeholders involved in the business of education and called for more rigorous teacher education training, aimed at breeding teachers competent enough to Mathematics.

Project-based method is one of the constructivists teaching methods in which the learners, individually or in groups undertake independent study or take home exercise. Project-based is practical-oriented and student-centered approach to teaching. It fosters critical thinking, problem-solving ability and entrenches philosophy of learning by doing, which helps to motivate interest, and enhance retention in subjects like Mathematics. The method has been used in several areas but was found particularly applicable in Mathematics. It

was first implemented in medical science in the 1950s specifically in the medical school in the United States. It was implemented in the medical school of McMaster University in Canada at the end of the 1960s (Harris, 2001). This teaching model is put into practice in medical faculties of many universities across the globe especially in Mexico, Turkey and recently in Nigeria. Project-based method of teaching involves assigning students to assume a particular role in learning. Students can be assigned into groups and cooperatives to design a particular project and implement it.

In recent times, project-based learning strategy was used to instruct learners of Quadratic Equation (Aristidou, 2020; Han, Yalvac, Capraro, M. M. & Capraro, R. M., 2015). This is an instructional technique that transforms learning from 'teachertelling' to 'student-doing' in which students are provided with task based on challenging questions or problems that involves the students problem-solving (Wekesa & Ongunya, 2016), decision-making (Sweetman, 2017), meaning-making, investigative skills and reflection, that includes teacher facilitation but not direction (Brockett & Hiemstra, 2018). Thus, project-based learning has the following advantages that makes it distinctive amongst other teaching pedagogies; it engages learners (Boss & Larmer, 2018; Johnson & Delawsky, 2013), boosts cooperative learning skills (Perez Poch, Sanchez Carracedo, Salan Ballesteros, & Lopez Alvarez, 2019; Lee, Huh & Reigeluth, 2015), improves academic performance (Guo, Saab, Post & Admiraal, 2020; Jaiswal, Karabiyik, Thomas & Magana, 2021), develops high order thinking skills and builds positive relationships between students and teachers (Sasson, Yehuda & Malkinson, 2018; Wibowo, Roektingroem, Bastian, & Hudda). This makes the technique a suitable instruction model in Algebraic Equations because the topic requires content knowledge, problem solving and creative thinking skills for

it to be well understood by learners.

Project-based learning technique has been successfully used in many countries to improve students' achievement in Mathematics and prepare them for life outside the four walls of the classroom. For instance, in Britain, there has been remarkable improvement in test mean scores in science subjects as a result of implementation of project-based learning pedagogy in teaching (see Fini, Awadallah, Parast, & Abu-Lebdah, 2018; Sunyoung, Rosli, Capraro, M. M & Capraro, R. M., 2016). In the United States of America, project based learning is well established through the support of the Buck Institute for Education (B.I.E) as a response to school reform efforts that required to equip learners with skill suitable in the knowledge-based economy (Krauss & Boss, 2013). In Japan and India, project-based learning is also well established (Inoue, Oda, Hasegawa, Mano, Yamazaki, Khantachawana, & Anityasari, 2020). However, In Nigeria, the education system was structured to be examination-oriented, and thus has not given room for student-centred methods of instruction (Filgona, Filgona & Linus, 2017).

Problem Statement

Despite the relevance of Mathematics in Science, Technology, Engineering, Arts and Mathematics (STEAM) related courses as well as Medical and Pharmaceutical sciences, students' performance in the subject in both internal and external examinations has remained consistently poor (Eswaran, 2022; Olagbaju & Popoola, 2020). Yet, many students entertain fear and have a dwindling interest in Mathematics, through absenteeism from Mathematics classes, paying little or no attention to lesson, continue to experience difficulties in answering questions particularly in area of Algebraic Equations (WAEC Chief Examiners' Report, 2019; Maor, 2020; Cuban, 2013); and thus, perform poorly in their examinations (Awofala, 2017; Ugodulunwa & Okolo, 2015; Okafor & Anaduaka, 2013). In addition to these literatures, there is overwhelming evidence on the poor performance of students in Mathematics in Sokoto state, occasioned by a number of factors, which include but not limited teachers' pedagogical incompetence, work overload, inadequate in-service training etc.

Conceptual Framework

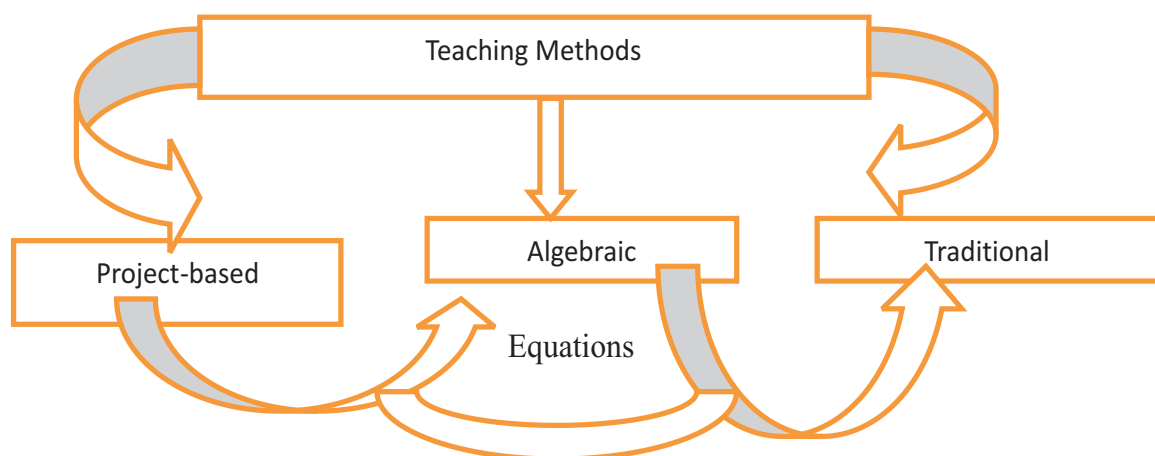


Figure 1: Diagrammatic representation of a conceptual framework for the paper

Figure 1 portrays the conceptual relationship between teaching method as a whole and the two other methods employed in addressing the problem of learning Algebraic Equations. Thus, a **teaching method** comprises of principles, methods and procedures used by teachers to enable students' learning (Wilkins, Jones & Rakes, 2021). These strategies are determined partly by subject matter to be taught and partly by the nature of the learner who is to be taught. For a particular teaching method to be appropriate and efficient it has to be in relation to the characteristic of the learner and the type of learning it is supposed to bring about in the learner (Taylor & Bangeni, 2021; Bardach & Klassen, 2021). The approaches for teaching can be broadly classified into teacher-centered and student-centered. In a teacher-centered approach to learning, teachers are the main authority figure in this model. Students are considered as "empty vessels" whose primary responsibility is to learn information passively with the aim of testing, assessment and evaluation (Kaume-Mwinzi, 2018).

It is therefore considered the primary role of teachers to impart knowledge and information to their students. That is what informed the choice of PBM which brings together both teachers and students. In this approach, teaching, assessment and evaluation are viewed as three distinct entities through which students' learning is measured objectively (Klassen & Kim, 2021). The teacher's primary role is to coach and facilitate students' learning and overall comprehension of material. Students' learning is measured through both formal and informal forms of assessment, including group projects, student portfolios, and class participation (Lin, Yin, Tang, Hadad & Zhai, 2020; Duruji, Azuh, Joshua, Olarenwaju & Okorie, 2014). Therefore, these two methods were used to teach students Algebraic Equations through this

conceptual approach.

Research Objectives

1. To find out the difference in the mean performance scores of students taught Algebraic Equations using project-based and traditional methods
2. To find out gender difference in the performance of students taught Algebraic Equations using project-based method of teaching

Research Questions

1. What is the difference in the mean performance scores of students taught Algebraic Equations using project-based and traditional methods?
2. What is the difference in the performance of male and female students taught Algebraic Equations using project-based method?

Null Hypotheses

Ho₁: There is no significant difference in the mean performance of students taught Algebraic Equations using project-based and traditional methods

Ho₂: There is no significant difference in the performance of male and female students taught Algebraic Equations using project-based method

Research Design

The research design adopted in this study was quasi-experimental. Quasi-experimental design is not fully experimental because it does not accommodate random assignment of subjects. Thus, intact classes were used in the selected schools. The intact classes were taught Algebraic Equations using project-based method. The reasons for the choice of this design is to enable the researcher have a controlled experiment without randomization of subjects. Like a true experiment, quasi experimental research design tries to establish cause and effect relationship. However, unlike true experiment,

it does not allow for random assignment of subjects. In other words, subjects are selected using “non-random” criteria.

Population, Sample and Instrumentation

The population of the study is the senior secondary school students from the six Educational Zones of Sokoto state. Thus, the total number of the population is sixteen thousand nine hundred and seventy nine ($N = 16,979$) SS II students of the six (6)

Educational Zones in Sokoto State. A sample of three hundred and fifty ($S = 250$) was drawn for study in line with the provision of (Krejcie & Morgan, 1970). An instrument named Algebraic Equations Performance Test (AEPT) was designed by the researcher. The instrument was validated and pilot tested prior to the commencement of the research and a reliability index of 0.92 was obtained using split half method of establishing reliability of a research instrument.

Table 1: Population and Sample of the Study

S/N	Educational Zones	Number of Students	Sample Size
1.	Sokoto North	1,346	42
2.	Sokoto South	6,986	42
3	Gwadabawa	1,428	42
4.	Goronyo	2,964	42
5.	Yabo	1,806	42
6.	Bodinga	2,449	40
	Total	16, 979	250

Source: Ministry of Basic & Secondary Education Sokoto (2021)

Results (Descriptive Analysis)

Research Question I:

What is the difference in the mean performance of students taught Algebraic Equations using project-based and traditional methods?

Table 2: Summary of the Mean Performance of students taught Algebraic Equations using Project-Based and Traditional Methods

Methods of Teaching	N	Mean	SD	Mean Difference
Project Based Method	125	13.91	1.66	5.75
Traditional Method	125	8.17	2.08	

Source: Research Fieldwork (2021)

The result in Table 2 showed the summary of the mean scores of students taught Quadratic Equations using project-based method of teaching as well as those taught Algebraic Equations using traditional method of teaching. The result indicates that the mean and standard deviation scores of students taught Algebraic Equations using project based method is 13.91

(SD = 1.66) while the mean and standard deviation scores of students taught Algebraic Equations using traditional method is 8.17 (SD = 2.08) and the mean difference of 5.75 was obtained. Thus, the result indicated that students taught Quadratic Equations using project-based method probably outperformed their counterparts taught Quadratic Equations using

discussion method. But the actual difference would be obtained at the hypothesis testing level.

Research Question II:

What is the difference in the performance of male and female students taught Quadratic Equations using project-based method of teaching?

Table 3: Summary of the Mean Performance between Male and Female students taught Quadratic Equations using Project-Based Method

Gender	N	Mean	SD	Mean Difference
Male	150	17.83	7.29	8.16
Female	100	9.66	3.13	

Source: Fieldwork (2021)

The result in Table 3 showed the summary of the mean performance of male and female students taught Algebraic Equations using project-based method of teaching. The result indicated that the mean and standard deviation scores of male students taught Algebraic Equations using project-based method is 17.83 (SD = 7.29) whereas the mean and standard deviation of female students taught Algebraic Equations using project-based method is 9.66 (SD = 3.13) and the mean difference of 8.16 was obtained. Thus, the result indicated that male students taught Algebraic Equations using project-based

method probably performed better than female students taught Algebraic Equations using project-based method of teaching. But the actual difference, whether significant or not, would be obtained at hypothesis testing level.

Results (Inferential Analysis)

Null Hypothesis H_0 :

There is no significant difference in mean performance scores of students taught quadratic equation using project-based and traditional methods of teaching.

Table 4: Summary of T -test of Students taught Algebraic Equations using Project-Based and Traditional Methods

Method	N	Mean	SD	DF	t-cal.	p-value	Decision
Project-based Method	200	13.91	1.66	374	24.26	0.004	H_0 Rejected
Traditional Method	175	8.17	2.08				

Source: Fieldwork (2021)

α -level of significance = 0.05

The result in Table 4 showed the t-test analysis of students taught Quadratic Equations using project-based and traditional methods of teaching. The result from the table revealed that the p-value of 0.004 was less than the alpha value ($p < 0.05$). Similarly, t-cal. is 24.26 which is greater than critical value of t, which is 1.96. Hence, the null hypothesis which stated that there is no significant difference in mean

performance scores of students taught quadratic equation using project-based method and traditional method, was rejected. This result indicated that significant difference exists between the two methods of teaching Algebraic Equations, i.e. project-based method and traditional method.

Null Hypothesis Ho₂:

There is no significant difference in the mean performance scores of male and female students

taught Algebraic Equations using project-based method

Table 5: Summary of T -test for Male and Female Students' Performance

Gender	N	Mean	SD	DF	t-cal.	p-value	Decision
Male	200	17.83	7.29	374	13.7	0.000	Ho Rejected
Female	175	9.66	3.13				

Source: Fieldwork (2021)

α -level of significance = 0.05

The result in Table 4 showed the t-test analysis of male and female students' performance taught Algebraic Equations using project-based method of teaching. The result from the table revealed that the p-value of 0.000 was less than the alpha value ($p < 0.05$). Similarly, t-cal. is 13.70 which is greater than the critical t value, which is 1.96. Hence, the null hypothesis which stated that there is no significant difference in the mean performance of male and female students taught Algebraic Equations using project-based method was rejected. This result indicated that significant different exists between the two genders of students i.e. male and female.

Conclusion

On the basis of the findings, it can be concluded that there was a significant difference between the performance of students taught Algebraic Equations using project-based method of teaching and those that were taught using traditional method of teaching. Similarly,

gender influence was found on the performance of students. Male students' performance was found to be greater than their female counterpart.

Recommendations

In line with the findings of the study, the following recommendations were given

1. That project-based method should be given more priority when teaching Algebraic Equations because it proved more efficient than traditional method.
2. That, female students should be given more attention when teaching Algebraic Equations because they were found to lag behind their male counterparts in performance.
3. That regular refresher course should be organized for teachers on emerging teaching strategies/methodologies so that they are kept abreast of the latest ways of teaching student.

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EFFECT OF SOLVE MNEMONIC STRATEGY AND LOCATION ON BASIC EDUCATION STUDENTS' RETENTION IN ALGEBRAIC WORD PROBLEMS IN NASARAWA STATE, NIGERIA

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Abstract

This study determined the Effect of Solve Mnemonic Strategy on Basic Education Students' retention in Algebraic Word Problems in Nasarawa State, Nigeria. The study adopted Quasi – Experimental, pretest, posttest post- posttest, non-equivalent control group design. The target population comprised all the 1853 JSII Students (1012 Male and 841 Female). The sample for the study consisted of 87 JS II Students from three intact classes out of which the experimental group consisted of 42 students (26 Urban and 16 Rural) while the control group consisted of 45 students (24 Urban and 21 Rural), their selection is purposeful in order to have data that have state representative. In choosing students, stratified random sampling technique was used on the bases of school location. The instrument for data collection was Algebraic Word Problems Achievement Test (AWPAT). The reliability of AWPAT was found to be $r=0.82$ using Split – Half Method. The data collected were analyzed and interpreted using mean and standard deviation to answer research questions and analysis of covariance (ANCOVA) to test the null hypotheses at 0.05 level of significance. The study revealed that Solve Mnemonic strategy and location can significantly affect the retention of algebraic word problems among basic education students in Nasarawa state, Nigeria. It is recommended that teachers should be trained on how to use mnemonic strategies when teaching algebraic problems and consider the location of their students in order to increase their retention of algebraic word problems.

Key words: Solve Mnemonic Strategy, Retention, Location, Algebraic Word Problems

Introduction

Mathematics is one of the core subjects that is taken very serious in the school system regardless of country or level of education. Mathematics is a subject that is generally acknowledged as important because of its relevance to science and technology. It involves calculation, computation, and solving of mathematical problems. Nneji and Alio (2017) stated that mathematics uncovers hidden patterns that help us to understand the world around us. Now, much more than arithmetic and geometry, mathematics today is a different discipline that deals with data, measurements and observations from science, with inference, deduction, and proof; and with mathematical models of natural phenomena, of human behavior, and of social systems. It may also be defined as, the study of quantity, structure, space and change; it has historically developed, through the use of abstraction and logical

reasoning, from counting, calculation, measurement, and the study of the shapes and motions of physical objects. Mathematic is a way to settle in the mind of children a habit of reasoning (Malik, 2017). Phonapichat, Wongwanich and Sujiva (2014), stated that the "functional" aspect of mathematics stems from its importance as the language of science, technology and engineering, and its role in their development. This involvement is as old as mathematics itself and it can be argued that without mathematics, there can be neither science, technology nor engineering.

More so, the National Policy on Education states that mathematics education aims at developing individuals who are able to think mathematically, who can apply mathematical knowledge effectively and responsibly in solving problems and making decisions (Federal Republic of Nigeria, 2014). One of the major challenges of mathematics in the school system

is how to learn its concepts and effectively retrieve the learned concepts. For learning to take place, students must interact with mathematics ideas in active and constructive way. There is need for students to be proactively involved in their learning; they should not be seen as people with nothing to offer, people who just go to school to receive knowledge from teachers.

Researchers such as Obi, Abugu and Ayogu (2015) observed that despite the practical utilization, scientific, technological and cultural values of mathematics, its teaching and learning are still characterized by lots of challenges. According to Adeniyi (2009), the cause of the widespread low level achievements of students in mathematics could largely be ascribed to mechanical and uninteresting teaching strategies mathematics teachers adopt which are lacking of understanding of the real meaning of mathematical concepts. Learning is a process which should produce desired changes in the behaviour of students. Consequently, the learning situations utilized in the classroom are important for the understanding of the concept taught. Learning occurs when insight is gained, and when the processes are understood, in short when interaction has taken place between the teacher and the learner and between learners and their peers. Some teachers still believe that knowledge is transferred to their students but in reality students learn by doing and this is reinforced by the use of innovative teaching strategies. Abdulhamid, Abubakar and Tela (2017) expressed that teaching mathematics requires application of effective methods that bring active learning, but the absence of this makes the students not to participate actively in a mathematics class.

Algebra as one of the major branches of mathematics concerns itself with the study of the rules of operations, relations, constructions, and the concepts arising from them, including terms, polynomials, equations, and algebraic structures

(Morris, 2009). Algebra, according to Adeniyi and Ibrahim (2015), is an aspect of mathematics which involves the use of letter and numbers. These letters combine with figures bring a lot of confusion to the students; more so, with the letters changing values or one letter replacing another letter at intervals. Although, algebra is considered as one of the most important aspects of school mathematics; it does not only play an important role in mathematics but functions as a gatekeeper to future educational and employment opportunities (Silver, 2017). Algebra is a foundation and language system on which higher order mathematics, sciences, technology and engineering courses are built (Musen, 2010). Algebra being useful in other branches of mathematics, gives compact formulae or generalization to be used in all cases. Algebra has practical value in many of the trades and industries, provides an effective way for expressing complicated relations, inculcates the power of analysis, and is a good instrument for mental training. Kaplan, Fisher and Rogness (2009) stated that algebra often serves as a gate keeper to success in post-secondary education, and many career paths. However, its learning has remained a significant challenge to students all over the world; there are three fundamental understanding in learning algebra which can serve as impediment to mastering it by many students. These are the abstract reasoning, the language, and the structure.

Again, algebraic word processes contains applications to word problem involving basic arithmetic operations with algebraic symbols, word problems leading to simple linear equations, simultaneous linear equations, quadratic equation, and practical applications to word problems. In view of the significance of mathematics to the individual's daily life and the society at large, it is anticipated that the students' achievement in the subject should be well above average. However, the persistent poor achievement of students in mathematics has

been a major concern for parents, mathematics educators and government who spend a lot of money in funding education but to no avail. Mashina and Timayi, (2015), ascribed the poor achievement of students to the curriculum and methods of teaching, rather than to student's lack of capacity to learn.

The selection of teaching technique is not an easy task; this is because there is no single method that seems to work well for everyone and for all situations. In addition, every teacher should identify appropriate methodology based on the nature of the subject matter and instruction to be given. Most teachers use irrelevant and ineffective methods of teaching which among other factors, contribute to students' poor achievement in mathematics. The need to find reliable ways of improving students' achievement and retention in mathematics is becoming an international issue. This is because the conventional method of teaching mathematics is no longer effective (Bolaji, Kajuru & Timayi, 2015). Also, the external mathematics examination is made up of algebraic word problems in form of mensuration, trigonometry, compound interest, to mention a few, which are to be translated into algebraic expressions or equations and solved. Students usually perform poorly in these areas and the NECO Chief Examiner reports (2010 - 2018) attributed the students' failure to poor grammatical expression, misinterpretation of questions, weakness in algebraic expression and word problems, among others.

The Chief Examiner reports suggested among other things, that students should try to read and understand the questions before answering them. For the candidates' weakness in algebraic expression and word problems, Kovarik (2012) posited that the inability of students to understand the vocabulary used in instructions and word problems are among the reasons. Kovarik explained further that although students may excel in computation, their ability to apply

their computational skills in algebra will be hindered if they do not understand the vocabulary used in instructions and in the word problems' tests. Hence, knowing and understanding the language of an instruction is an important factor in relation to how successful the student would be, especially as it involves word problems (Adams, 2013). The difficulty of these algebraic words may be a major part responsible for poor achievement in mathematics.

Word problems are simply problems situated in a real-life context; it is this characteristic that differentiates them from other types of problems (Verschaffel, van Dooren, Greer, & Mukhopadhyay, 2010). This context requires students to read and understand to solve the problem while at the same time incorporate their mathematical understanding. As word problems are not given in a "plain" mathematical expression, they require complex steps to solve (i.e. reading, comprehending, transforming into mathematical expression, processing the mathematics, interpreting result to context given, and evaluating the result) (Reys, Lindquist, Lambdin, & Smith, 2008; Ryan & Williams, 2007). Despite their real life context, the context of word problems is "situated" or encoded into syntax and expression, familiar to mathematics (Reed, 2009). The role of students in reading and comprehending the words in word problems as such are affected by this mathematically-situated context.

In addition, memory of factual information is essential for success in addressing inconsistencies in mathematics achievement; additional studies are needed to determine if mnemonic strategy instruction can be considered an evidence based practice in mathematics as well. There are a number of mathematical mnemonic strategies (SOLVE, TINS) that are being used by secondary teachers across United States of America. For example, the National Training Network has published

curricula (e.g., *Algebraic Thinking*) that are being implemented across the U.S.A by districts and individual schools with the SOLVE and TINS mnemonic strategies as some of its major components. Teachers are required to provide students with explicit instruction on the process of word mnemonic; however, they are confronted with determining effective instruction to produce the best learning outcomes of their students (Miller, 2007).

Mnemonic means are often applied in mathematics instruction to help students memorize steps or operations (Mastropieri & Scruggs, 2013). A number of mnemonics means have been used with these students in learning mnemonic skills such as *SOLVE* and *TINS* with an acronym to represent each step for learners to follow. *SOLVE* is a mnemonic strategy, representing studying the problem, organizing the facts, lining up a plan, verifying the plan with action, and evaluating the answer (Mastropieri & Scruggs, 2013). *SOLVE* mnemonic strategy is taught through Direct Instruction by breaking down the skill into a step-by-step procedure; for example, lessons address each of the five steps in small parts of information. First, students learn how to solve a word problem by following a sequence which begins with studying the problem. In this step, students are instructed to determine what the problem is being asked. The second step is to organize the facts. Students are shown how to identify the important facts in the problem. The third step is to line up a plan. Students are instructed to plan to solve the problem without using numbers. The fourth step is to verify the plan with action. Students learn to verify the plan they created in the third step, plug in numbers and solve the equation. The final step is to evaluate the answer. Students are shown how to check their results by asking questions such as, does the answer make sense or is it reasonable and correct? *SOLVE* was shown to be a strong starting point for secondary school students to learn building mnemonic skills, such

as organizing information and identifying what is important in a problem (Mastropieri & Scruggs, 2013). The explicit instruction, to teach *SOLVE* in a step-by step format has ensured that students have repeated practice and guidance during the process of learning.

Closely connected to achievement is retention. This is because if knowledge is retained, then it can be recalled when needed. Retention is the act of transferring information from short term memory to long term memory (Okeke, 2011). Retention comes in before recall. It is recall that reveals how much knowledge the students have retained after the teaching and learning. Retention can be the extent to which one can retrieve information from long term memory. The success of retrieval depends upon effective encoding (meaningful learning) that involves making associations with existing knowledge that can facilitate future retrieval among students irrespective of their gender. Research evidence have consistently indicated teaching method as a major factor determining the achievement and retention of students in mathematics. Hence the search for better methods and newer innovations is a great challenge facing mathematics educators.

School location is another moderator variable whose choice is based on research reports that there is a variation in the achievement of students in mathematics in terms of school location (rural or urban) appears to affect students' achievement and retention in mathematics. Olueh (2016) surveyed the works of different researchers on school location and achievement and found that there were sharp contrasts between rural and urban schools in terms of staff quality and instructional facilities.

Research Questions

The following research questions guided the study:

1. What are the mean retention scores of JSII students taught algebraic word problems

using SOLVE mnemonic strategy and conventional method?

2. What are the mean retention scores of male and female JSII students taught algebraic word problems using SOLVE mnemonic strategy?

Test of Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

H_{01} : There is no significant difference in the mean retention scores of JSII students taught algebraic word problems using SOLVE problem solving strategy and conventional method.

H_{02} : There is no significant difference in the mean retention scores of male and female JSII students taught algebraic word problems using SOLVE mnemonic strategy

Methodology

This study adopted quasi-experimental design of pretest posttest, post-posttest non-equivalent control group design. The population of the study consisted of all the junior secondary school students' studying mathematics in Nasarawa State. The target population of the study comprised all the JSII students in the public co-education schools. It was made up of a total of 1853 students (1012 males and 841 females) in the 2020-2021 academic session. The sample for the study consisted of 87 JS II students from four junior secondary schools. The study adopted multi-stage random sampling technique. Out of the three senatorial zones in Nasarawa State, three Local Government Areas (LGAs) were selected, namely; Akwanga, Lafia and Keffi. Their selection was purposeful in order to have a data that have State representation. Using the ballot technique, two schools from each of the three selected LGAs were used. Co-educational schools were drawn from the list of schools in the area of study, the bases for the selection of the participating schools were: The schools must be co-

educational, there must be qualified mathematics teachers who have been in the schools for a minimum of 3 years, as well as school location, willingness on the part of the schools to cooperate with the researcher, and the schools must be distant from each other to avoid interaction effects. In each school, one intact class was randomly drawn and the number in each class was collected through physical presence of students.

Algebraic word problem achievement test (AWPAT) was the instrument used for data collection. It was developed by the researcher, and consisted of 50 objective test items using content on algebraic word problem concepts. This topic is derived from the national curriculum for junior secondary school mathematics and it was selected because it features in (JSS2) mathematics curriculum. It was used to determine the achievement of students in algebraic word problem concept in mathematics. As a multiple choice objective test, AWPAT had four options lettered A-D. The instrument was structured according to level of the cognitive domain. The instrument upon validation was trial tested on 32 JS II students in order to establish the reliability coefficient of the instrument. The internal consistency of AWPAT was found to be 0.82. The data collected was analyzed and interpreted using mean and standard deviation to answer research questions. Analysis of covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance.

Results

Research Question 1

What are the mean retention scores of JSII students taught algebraic word problems using SOLVE mnemonic strategy and conventional method?

In Table 1 are data used to answer research question 1.

Table 1: Mean retention Scores and Standard Deviation of Basic Education Students taught AWP AT in SOLVE Mnemonic Strategy and Conventional Method

Strategies	N	Post-Test		Post-Posttest		Retention mean difference
		Mean	SD	Mean	SD	
SOLVE	42	24.12	2.62	26.05	2.14	(1.93)
Conventional Method	45	13.76	1.45	17.36	2.19	(3.60)
Total	87	10.36		8.69		1.67

Table 1 showed the retention scores and standard deviation of experimental group and the control group in the posttest and post-posttest, the retention scores and standard deviation of SOLVE mnemonic strategy was (24.12, 2.62) and (26.05, 2.14), conventional method (13.76, 1.45) and (17.36, 2.19) with retention mean difference of 1.67.

Hypothesis 1

There is no significant difference in the mean retention scores of JSII students taught algebraic word problems using SOLVE problem solving strategy and conventional method.

The data presented in Table 3 were used to test hypothesis 1.

Table 3 : ANCOVA Results on Basic Education Students Taught AWP AT Using SOLVE Mnemonic Strategy and Conventional Method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	46.46576	2	1548.859	398.463	0.000
Intercept	426.782	1	426.782	109.795	0.000
Posttest	41.774	1	41.774	10.747	0.001
Strategies	357.926	2	178.963	4.6041	0.000
Error	470.336	85	3.887		
Total	36067.000	87			
Corrected Total	511.6912	86			

Table 3 ANCOVA result revealed that there was a statistical significant mean difference between SOLVE Mnemonic Strategy and Conventional method ($F(1, 87) = 46.041, p = 0.000, \alpha = 0.05$). Hypothesis was rejected at 0.05 alpha level.

Research Question 2

What are the mean retention scores of JSII students taught algebraic word problems using SOLVE mnemonic strategy in urban and rural schools?

Data used to answer research question 2 are presented in Table 2.

Table 2: Mean retention Scores and Standard Deviation of Basic Education Students' taught AWPAT Using SOLVE Mnemonic Strategy Based on location

Location	N	Post-Test		Post-Posttest		Retention mean difference
		Mean	SD	Mean	SD	
Urban	26	20.26	5.53	25.30	6.89	(5.04)
Rural	16	20.41	5.02	25.67	5.69	(5.26)
TOTAL	42	0.15		0.37		0.22

Table 2 showed the retention mean scores and standard deviation in the posttest and post-posttest of SOLVE mnemonic strategy in terms of location. Urban students' retention mean scores was (20.26, 5.53) and (25.30, 6.89) with retention gain of 5.04, while their rural counterparts mean scores was (20.41, 5.02) and (25.67, 5.69) with retention mean gain of 5.04 and 5.26 and retention mean difference of 0.22.

Hypothesis 2

Table 4: ANCOVA Results on Basic Education Students' taught AWP using SOLVE mnemonic Strategy Based on Location

There is no significant difference in the mean retention scores of male and female JSII students taught algebraic word problems using SOLVE problem solving strategy. The data of Table 4 were used to test hypothesis 2.

Table 4 revealed that there was a statistical significant retention difference between the urban and rural students that were taught algebraic word problems using SOLVE strategy ($F(1, 39) = 5.230, P = 0.128, \alpha = 0.05$). The hypothesis was not rejected at 0.05 alpha level of significance.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	30.129	2	15.064	3.724	0.033
Intercept	255.797	1	255.797	63.229	0.000
Posttest	18.436	1	18.436	4.557	0.039
Location	21.160	1	21.160	5.230	0.128
Error	157.776	39	4.046		
Total	38108.000	42			
Corrected Total	187.905	41			

word problems using SOLVE mnemonic strategy, even though, the rural students had higher retention mean scores than the urban students in the retention test. The findings of the

Discussion of Findings

The findings of the study showed that SOLVE mnemonic strategy improved JSII students' retention in algebraic word problems compared to students that were taught using conventional method. Similarly, SOLVE mnemonic strategy enhanced students' retention in algebraic word problems compared to conventional method. The findings are in line with the work of Siegel (2017) who found that students achieved better with mnemonic mode of instruction. The findings are also in agreement with the works of Akinsola and Odeyemi (2014) who found that mnemonic strategies enhanced students' achievement in mathematics. Since this is the case, teachers should create mnemonics that link old and new information in the students' memory. The findings are as well in line with Maghy (2015) whose work revealed that mnemonic strategy is more effective than the lecture method.

The findings further revealed that urban and rural students retain equally in algebraic

study further revealed that SOLVE mnemonics strategy enhanced JS students' retention in algebraic word problems of urban and rural schools' students' equally. This signifies that both

urban and rural school students' benefitted from SOLVE Mnemonic strategy. Obviously, the result in this study is in contrast with that of Olueh (2016) who found that location of school (urban or rural) appears to affect students' achievement and retention in mathematics.

Conclusion and Recommendations

By implication, this confirmed that students' retention in algebraic word problems depend on the method of instruction. Thus, SOLVE Mnemonic Strategy is meaningfully a very useful instructional strategy for increased meaningful learning and higher retention of basic students regardless of their location. It can be acknowledged that teachers' regular use of

this strategy will certainly enhance teaching output to a great extent. Based on the results of the data analysis, the following recommendations are made.

1. Mathematics teachers should be exposed to SOLVE mnemonic in their instructional strategies through seminars or training to improve their inputs during teaching–learning.
2. mathematics teachers should vary their instructional style by using SOLVE as against consistent use of Conventional Learning Strategy. This will increase the academic retention of mathematics students.

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MATHEMATICS EDUCATION: A TOOL FOR FOOD AND NATIONAL SECURITY

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Abstract

Mathematics as a discipline encompasses several areas and is a pathway to many careers. This paper considers Mathematics as an inevitable tool for food and national security. Security is the protection from danger or worry which indicates measures taken to guarantee the safety of an individual, structure, organization or a nation. The different forms of security and the role Mathematics play are examined. CCTV is a technology that is used to manage crimes and security problems in the country. Mathematics plays a major role in security system. Mathematics is also important in the production and processing of food for the nation. Mathematics takes place from the farm to fork. This paper therefore examines the importance and role of mathematics in the provision of food and national security. Recommendations were made that farmers should be adequately trained in Mathematics (at least in concepts that they need to know). There should be effective and functional mathematics education at all levels so as to transform skills realized for mathematics to solve the nation's security challenges. Also, government should encourage the use of CCTV in public places (like schools, hospital, offices, supermarkets etc.) to reduce crimes and security problems.

Keywords: Mathematics Education, Food Security, National Security.

Introduction

Food is the basic necessity of man. It is a mixture of different nutrients such as carbohydrate, protein, fat, vitamins and minerals. These nutrients are essential for growth, development, and maintenance of good health throughout life. They make us to be active, to move, play, work, think and learn. Food is the third most important thing for living beings to provide energy and development, maintain life, or stimulate growth after air and water. It is one of the most complicated sets of chemicals. Food plays an important role in the promotion of health and disease prevention. It is directly related to our body and mental and social health. In general, the essential nutrients contained in food are consumed by man to provide nutritional support and to sustain health. These nutritious foods are in the form of grains, pulses, fruits, vegetables, oils, etc. Food is secured through several methods: agriculture, hunting, gathering, etc. Most foods have their origin in plants. Some foods are derived directly from plants, but even

animals are also used as food sources that are picked up by feeding food from plants.

Adah, Enemali, Adejoh and Edoka (2015) asserted that agriculture being one of the several methods of obtaining food has been the mainstay of the nation's economy in Nigeria. It provides food for the ever rapidly increasing population. People especially the rural dwellers are gainfully employed on their crop farms and small scale livestock farms for income earning. Realizing that the power of any nation lies in her ability to feed her citizenry, government has been making a lot of efforts to improve agriculture in the country in the past decades. These have been in the area of mounting different successive programmes such as Operation Feed the Nation (OFN), Green Revolution Programme (GRP) and Agricultural Development Programmes (ADPs).

It is in the light of the above that the development of agriculture, a worldwide practice of raising crops and animals for satisfying human wants

becomes imperative and worthwhile (Adedayo, 1999). This is where science, technology and mathematics come in. Hence, Ochekliye in Enemali and Adah (2015a) maintained that no country in recent age can develop or even hope to maintain its existence without science, technology and mathematics.

Abubakar, Charles-Ogan, Wokocho and Okoro (2015) viewed security as the act of keeping safe. Safety is the watch word of people that are security conscious. Security system comes in all forms and types. Mathematics is evident in each form of Security.

The Concept of Mathematics

Mathematics is the key to the solution of most human problems. Mathematics is the language of technology. It is used to formulate, interpret, and solve problems in fields as diverse as engineering, economics, communication, seismology, and ecology. Mathematics provides us with powerful theoretical and computational techniques to advance our understanding of the modern world and societal problems, and to develop and manage the technology industries that are the backbone of our economy (Leon-Seitelman, 1994). Ibidapo-Obe (2010) opined that Mathematics Knowledge is fundamental in addressing the critical issues of economic transformation and globalization, reduction of unemployment, poverty alleviation, hunger and disease and the sustainable effective use of natural resources facing the world today. Mathematics is a branch of knowledge that deals with measurement, numbers and quantities. Mathematics as a tool, its knowledge and skills are the bedrock of idea into reality (Abubakar, Wokoma & Afebuame, 2012). Enemali and Adah (2015a) underscored the significant role of Mathematics in various human endeavors when both stressed that mathematics is the foundation of Science and Technology without which a nation can never be prosperous and economically independent.

The knowledge of mathematics is an essential tool in everyday human life. Almost all activities whether social, economic or political needs the knowledge of mathematics to function properly. Johnson and Rising (1972) described mathematics as a creation of the human mind, concerned primarily with ideas, processes and reasoning. They view it as a way of thinking which makes it useful in the solution of all kinds of problems. According to Onoja (1999), mathematics is therefore characterized with clarity and precision that enable us to perform computations, solve problems and complete proofs with ease. To Eredugba in Onoja (1999) mathematics is regarded as a 'tool subject' because it is useful in the breaking down of verbal arguments into concise and consistent forms. Supporting this, Idoko (1999) in a study maintains that mathematics provides a powerful technique of analysis which can be used to prove or disprove theories in economics; and by extension, agricultural development. Ngoka (1993) observed that mathematics as well as science and technology is an important sphere in learning which greatly influence the level, nature, scope and direction of development of any nation. This is because the language of mathematics is regarded by many people as the life wire in the studies of various disciplines including agriculture.

From the foregoing, in all spheres of life, including agriculture, application of mathematics has been found to be key (Enemali & Adah, 2015a). Hence, Umaru (1995) conceptualized mathematics as a language which provides an indispensable means of investigating the nature of things particularly those which are dealt with in the field of science, technology, engineering and industry; and by extension agriculture and agricultural development. Otunu-Ogbisi and Ukpebor (2009) see mathematics as an effective tool for solving crime and security problems. It is on the basis of this that the paper examines

mathematics as a tool for food and National Security.

Objectives of Mathematics Education in Nigeria-An Overview

Owing to the importance of mathematics in nation building, the Federal Government of Nigeria via its National Policy on Education (NPE) hold that education in the country must be geared towards the provision of trained manpower in applied sciences, technology and commerce. The main objectives of mathematics education are as follows:

- Acquisition of certain mental attitudes that will facilitate the development of problem solving attitudes and strategies.
- Acquisition of the techniques of representation and interpretation of numerical and non-numerical forms of data.
- Training of the mind in the abilities to measure, approximate and estimate numbers and other quantities.
- Acquisition of functional and basic numeracy skills, relating to how and when to use arithmetic operations on both whole numbers and decimal fractions and
- Acquisition of spatial concepts and the ability to represent these concepts using such tools as maps, and others scales for drawing (NPE, 2014).

At junior and senior secondary education level, some of the objectives of mathematics education are:

- Development of creativity, originality and curiosity in the learners at both levels
- Acquisition of relevant manipulation skills
- Laying emphasis on the wide applicability of mathematics in various fields of learning and in the world of work and

- Leading learners to discover and appreciate the beauty and elegance of mathematics (FGN, 2014).

These objectives were formulated in line with the overall philosophy of the country which are:

- i. Live in unity and harmony as one indivisible, indissoluble democratic and sovereign nation founded on the principles of freedom, equality and justice;
- ii. Promote inter-African solidarity and world peace through understanding. (FGN, 2014:4).

The Role of Mathematics in Provision of Food

Right from the beginning of food production which takes place on the farm, Mathematics is very important in every stage of food production. Within the broad concept of farming, there are two very important elements: time and money. At the root of both of these is Mathematics. Mathematics has enabled farming to be more economically efficient and has increased productivity. Farmers use Mathematics as a system of organization to effectively utilize their time and manage their money. Farmers use numbers every day for a variety of tasks, from measuring and weighing, to land marking. One of the most frequently used Mathematics concept on the farm is the use of proportions. Also, farmers use Mathematics when applying chemicals and fertilizers to crops. A farmer may want to spray 160 acres at 0.8L/ hectare and needs to know how much chemicals he should purchase. Different chemicals are applied at different rates for different crops at different times during the growing season (Glyndon in Amao & Bakare, 2021). When working with fertilizers farmers must determine how much of a particular nutrient is needed for a specific crop, and apply the fertilizers accordingly.

Mathematics is vitally important to the food industry and many of the processes of dealing

with food. From farm to fork, and from fork to the sewers, Mathematics is an essential ingredient.

It explains and models the processes which govern the safe production, storage, testing, transport, cooking, eating and digestion of food. It helps decide whether and how it is safe to cook, eat and digest food stuff (Chris, 2010). Using Mathematics we can model the process by which food is heated in the oven and compare the effectiveness of the turntable and mode-stirred designs of the micro-wave oven. An application of Mathematics helps to predict when biscuits crack, and can thus reduce the chance of them cracking when they are made. Mathematics play an important part in everyone's life, but the increasing complexity of agricultural technology makes it mandatory that workers in agricultural occupations have skills in the analysis and solutions of mathematical problems. Mathematics plays a very significant role in agriculture, but most of the time we do not even realize it. Through meticulous planning and calculating, a farmer can predict his crop yield, expenditure, income and much more with the basic knowledge of Mathematics.

The Role of Mathematics in Food Security

Food security as a concept originated only in the mid-1970s, in the discussions of international food problems at a time of global food crisis. The initial focus of attention was primarily on food supply problems - of assuring the availability and to some degree the price stability of basic foodstuffs at the international and national level. That supply-side, international and institutional set of concerns reflected the changing organization of the global food economy that had precipitated the crisis. A process of international negotiation followed, leading to the World Food Conference of 1974, and a new set of institutional arrangements covering information, resources for promoting food security and forums for dialogue on policy

issues (Overseas Development Institute, 1997).

Food security is a measure of the availability of [food](#) and individuals' [ability to access it](#). According to *Food and Agriculture Organization (FAO) (2002)*, food security is defined as meaning that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life. Omonona and Agoi (2007) identified three pillars that explain food security namely: Availability, Accessibility and Utilization. According to them, Availability refers to the physical presence of a large quantity of food and accessibility means reaching the food while utilization means sufficiency in both quantity and quality of food and sustainability implies access to food at all times without losing such access. Food security is a problem for everyone especially the developing world. Moreover, it means provision and access to nutritionally sufficient and culturally accepted food by each member of the household to a healthy life obtained through socially accepted way. To Coleman-Jensen *et al* (2011), it means consistent, dependable access to enough food for active and healthy living. The availability of food irrespective of class, gender or region is another one. There is evidence of food security being a concern many thousands of years ago, with central authorities in [ancient China](#) and [ancient Egypt](#) being known to release food from storage in times of famine. At the 1974 [World Food Conference](#) the term "food security" was defined with an emphasis on supply; food security is defined as the "availability at all times of adequate, nourishing, diverse, balanced and moderate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (*Food and Agriculture Organization (FAO), 2003*). Later definitions added demand and access issues to the definition. The first World Food Summit, held in

1996, stated that food security "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (*Food and Agriculture Organization (FAO), 1996; Raj, 2013*). Similarly, [household](#) food security is considered to exist when all members, at all times, have access to enough food for an active, [healthy](#) life ([United States Department of Agriculture \(USDA\)](#), nd). Individuals who are food secure do not live in [hunger](#) or fear of [starvation](#) (*Food and Agriculture Organization (FAO), 2006*).

There has been an incessant food shortage the world over. Carletto, Zezza and Banerjee (2013) identified the elements of a strategy built around a combination of short term fixes, and long term methodological advancements to reverse the existing trends of poor coordination and slow methodological innovation in food measurements and monitoring. Food security indicators are all derived from country's level household income and expenditure surveys to estimate per capital caloric availability. Several measures that have been developed by United States Agency for International Development (USAID) funded and nutrition technical assistance (FANTA) include:

1. Household food in security access scale (HFIAS).
2. Household dietary diversity scale (HDDS): measures the number of different food groups consumed over a specific reference period (24hours/48hours/7days).
3. Household hunger scale (HHS): measures the experience of household food deprivation based on a set of predictable reaction based on a set of predictable reactions captured through a survey and summarized in a scale.
4. Coping strategies index (CSI): assess household behaviour and rates them

based on asset of varied establishment behaviours on how households cope with food shortages. Food security can be explicitly explained using percentages, rates, graph and numbering.

Fadare and Okogbe (2020) asserted that in food production, a topic like linear programming is used in the design of animal feeding stuffs. Feeds for livestock are mixed using specific mixing ratio or proportion. If the ingredients are not in the correct proportion, a deficiency or excess or surplus of one of the components leads to the death of the animal or an overall loss of money. Also the production of fertilizers, herbicides, insecticides, manure rate, seed rate, food processing and preservation need direct applications of Mathematics. The use of ionizing radiation has helped in different food preservation. Mathematical processes are applied in the composition of animal feed to quicken digestion.

They further presented the practical roles of Mathematics in Agriculture which in turn promote food security:

1. Mathematics allows the farmers to design better climate models. Accurate weather forecast is pertinent in the agricultural sector.
2. Mathematics improves the accuracy of soil analysis. Mathematics skills are useful for the analysis of soil acidity level as well as the moisture content. Measuring and monitoring these allow farmers to determine accurately the kind of crops that would thrive in which type of soil as well as the brand of fertilizer that would be utilized in the process.
3. Mathematics makes chemical content analysis for fertilizer more accurate. Fertilizers are typically made up of various chemical components in precise proportions. Farmers are supposed to determine which chemical nutrients are necessary for which crops and in which amounts. The fertilizers must be applied in specific quantities. Otherwise the yield fails.

4. Conversion of units requires a strong background of Mathematics. The units related with farming includes hectares, acres, grammes, kilogrammes, tones, hours, days, minutes, metres, feet and among others. All these units require mathematical skills and knowledge to convert from one category to another. For example, land is measured in acres, hectares, metres and feet while liquids are measured in litres and solids in grammes, kilogrammes and tones. An understanding of these units and how to apply them in real life is necessary for agriculture.

5. Planning, plotting and laying out plots sizes and dimensions, the area of the plot are some of the important factors to consider in the process of planting crops. Since farming is unpredictable owing to changeable climates and weather patterns, farmers must determine the crop yield by assessing the square footage of plot. This helps to approximate the yield in relation to the size of land available.

6. Improving estimates for expenditure and yields. With Mathematics, a farmer can control the expenditure income; they can also calculate the losses that he/she may incur in the process. Mathematical skills are necessary as they allow a farmer to account for all the money spent.

7. Mathematics lays the foundation for innovation in agricultural methods. All of the most important innovations throughout history are made possible because of Mathematics. The case is no different in the world of farming.

8. Farmers also estimate the element of time. They know approximately how many hours needed for a particular seed to germinate and this guide them in their planning as to when to plant the seed to avoid it germinating at the time they don't want or expect. They know the gestation period for various livestock, thus they plan when to allow mating of the animal particularly when breeding for a target market or season or festive period. Application of drugs and vaccine to livestock is mostly recommended

to be diluted in about 30% of daily water consumption of livestock and should be applied within a 2-hour time frame. So a farmer need to measure the amount of water his/her birds would exhaust within 2 hours' time frame, otherwise the left over after 2 hours become wasted.

9. Farmers take critical decisions based on past trends of recorded events (Statistics is needed here).

10. When going for shopping, they apply Mathematics to decide what and what not to buy to maximize their profit or avoid running at a loss.

11. Vaccines and drug for livestock such as chicken, cattle, turkey, swine and sheep are sold in specific doses. A farmer who does not plan Mathematically will just buy any number of day old chick, buy vaccines and inject chicks with a fractional quantity of the vaccine and throwing a larger part of it away as leftover or waste; whereas another farmer who is mathematically inclined will sit down and plan before booking for day old chicks proportional to available vaccine doses, and by implication, may not waste a single dose of the vaccine, thus maximizing his profit. By the time the former farmer backs out due to loss, the later will still be afloat in the poultry business.

12. The chemicals, vaccines drugs and other soluble (or injectable) are supplied in high concentration, thus calling for diluting them in recommended solvent in given proportions. Over or under diluting them has adverse effect on the livestock that drink them. Knowledge of Geometry is useful when a farmer uses his sprayer pump to apply insecticide, herbicide and fungicide. Applying Mathematics skills help the farmers to avoid a lot of waste in the process and this help him to maximize his profit and yields.

National Security in Nigeria

According to Bala and Ouedraogo (2018) Nigeria has well over 180 million people with different religious beliefs from more than 250

ethnic groups. In addition to those challenges, the country was built on regional and ethnic rivalries (Bala & Ouedraogo, 2018). Most recent security challenges facing the country include, but not limited to, militancy in the oil producing part of the country (Niger Delta) in the south; cattle rearers and farmers, Boko Haram, banditry and kidnapping in the north, break up movement in the east and a host of others. In 2014 National Security strategy plan was put in place to essentially answer both the national security interests as well as threats to national security. A key national interest centred around the security as well as the welfare of its people, sovereignty, and defence of its territorial integrity, peace, democracy and economic growth and social justice (Bala & Ouedraogo, 2018). On the other hand threats to national security as mentioned earlier include crude oil theft and pipeline vandalization, ethnic and religious conflicts, cattle rearers and farmers' conflict, Boko Haram, banditry and kidnapping, break up movements. These issues raised above are threat to national interest and are serious problems facing Nigeria.

Role of Mathematics in National Security

Mathematical sciences play a key role in many important areas of Homeland security including data mining and image analysis and voice recognition for intelligence analysis, encryption and decryption for intelligence gathering and computer security, detection and epidemiology of bioterrorist attacks to determine their scope, and data fusion to analyse information coming from simultaneously from several sources (National Research Council, 2004). In addition to the traditional area of cryptology, Mathematicians at the National Security Agency now work on problems such as signal analysis, speech processing, coding theory, data compression, analysis of communication networks and computer security. To solve problems generated by NSA's mission, mathematicians draw from a wide body of

mathematical knowledge, ranging from Number theory, Finite field theory, Fourier analysis, Probability, Statistics and more. However, many times, the essential ingredient to the solution of a problem is not mathematical knowledge per se, but the keen analytic ability that a mathematician possesses through training and talent (National Security Agency). Closed Circuit Television (CCTV) is a technological system of video surveillance by cameras. CCTV systems have expanded to facial recognition systems, infrared devices, computerized databases to track people, recording of sounds and voices (microphones), automated license plate identification, cellular alarms communication, roving video surveillance, unmanned aerial vehicles and wireless high-speed computer networks that transfer images at faster rates and improved quality. Currently, there is available software that translates facial features into simple mathematical formulas that can be checked against data banks at faster pace (Leman-Langlois, 2013).

Cryptography is a data security that makes use of Number Theory (Modular Arithmetic) and concept of Prime Number, and is the science of using mathematics to encrypt and decrypt data. Data security is a chief security concern when it comes to transmission of computer passwords, electronic ecommerce, private conversations and Automatic Teller machine (ATM) cards (Jiang, 2013). Cryptography is the practice of hiding information, converting some secret information to a non-readable text. It enables one to store sensitive information or transmit it across insecure networks (like the internet) so that it cannot be read by anyone except the right person(s). Applications of cryptography include military information and intelligence, electronic commerce, bank and payments and electronic building access. It is one of the cornerstones of internet security (Zakariyya & Barwa, 2013).

Wavelet Transformation (Signals Intelligence) is a new technique which is very important in all types of signal transmission and it is based on transmission of a series of numbers. Wavelet analysis is an exciting new method which applies principles of mathematics and physics in solving difficult civil and security problems. Some applications of wavelets are powerful statistical tool which can be used for a wide range of applications namely:

- Signal processing
- Data compression
- Fingerprint (which is more surprising), for detecting the properties of quick variation of values In internet traffic description for designing the services size
- Industrial supervision of gear-wheel
- Computer graphics and multi-fractal analysis
- Wave propagation
- Image processing
- Pattern recognition
- Detection of aircraft and submarines.

Wavelets process complex information at different positions and scales and reconstructs them with high precision (Zakariyga & Barwa, 2013).

Mathematics plays an important role in financial security. According to Abubakar, Charles-Ogan and Albert (2014), financial security involves financial instrument which is a tradable asset of any kind, either cash, evidence of an ownership interest in an entity or a contractual right to receive or deliver cash or another financial instrument. Mathematics skills such as counting and budgeting are needed for personal financial security. Also skills such as identification of numbers and correct valuation of money are needed for easy assessing of ATM cards and detection of fraud respectively. In the banks, savings, assets and liabilities, and bonds are valued using numbers. Loans, overdrafts and Commission On Transaction (COT) are given out using simple or compound interest rates. Also mathematical

skills consistency is required when for example a share price is taken and stochastic calculus is used to obtain the corresponding value of derivatives of the stock.

Economic security is measured using economic indices to measure the economic well-being of a nation. Mathematical skills are utilized to measure these indices. One primary indicator used to gauge the economic health of a country is the Gross Domestic Product (GDP). A negative GDP is a sign of recession which signifies unhealthiness while a positive GDP implies healthiness. Other economic indicators that requires mathematics skills are: Human Capital Index (HCT), Education Index (EI), Mean Years of Schooling Index (MYSI), Expected Years of School Index (EYSI), Income Index (II) and Consumer Price index which is used to measure reflection ultimately, the aspects of ratio, percentages, ordinal counting and algebra of numbers are essential mathematics to be used to be able to interpret the economy of any nation.

Detection and epidemiology of Bioterrorist attacks involves a number of lines of Mathematics research. The development of mathematical models of how diseases spread is perhaps one of the most well-known examples-well known in part because simple scenarios from standard examples in calculus classes. In fact, within days of the September 11 attack on the world Trade Centre Towers and The Pentagons, researchers at Los Alamos National Laboratory had taken a mathematical model of traffic flow they had been developing and applied it to predict the likely spread of disease following a possible attack. Another area where Mathematics will be important in countering a biological or chemical attack is in early detection that such an attack has in fact taken place.

The quantitative aspect of microbial inactivation, growth, of chemical, biochemical changes in food safety, quality, stability and nutritional value. These aspects have become even more important now, as new preservation

technologies are being developed and concern about the safety of foods is growing. Safety nutrition and quality issues also affect the economics of food production, processing and handling. Maintaining of the safety of foods without sacrificing their quality and nutritional value requires accurate quantitative methods to assess what constitutes microbial safety, how it changes with time, how to accomplishing it and how the process and post process history affect the food's quality, and in some cases its chemical safety (Micha, 2014). Today's terrorists operate globally, maintaining contact by telephone and the internet. Identifying the occasional key telephone and internet conversation among the millions that take place daily can only be done (if it can be done at all) using sophisticated automation, with monitoring systems that are able to breakdown voices and words into digital patterns that can be scanned for keywords. These require the development of new algorithms to monitor communications channels in real time to provide the nation's defence authorities with early warnings of a potential threat. Similarly, methods need to be developed for the automated screening of images sent over the internet, to look for messages embedded pictures (Steganography) a technique believed to have been used by the September 11 terrorists. New and more sophisticated mathematical techniques for image processing and recognition will also be required to identify potential terrorists involved in suspicious activities and to improve screening at the airports and other checkpoints (Keith in Amao & Bakare, 2021).

Conclusion

The paper concludes that food and security problems have been of utmost concern to the world especially Nigerians. Certainly the advancements in the areas of science and technology are indebted to mathematics to a great extent. The nation's security systems also owe their functionality on the abundance of

mathematics education. There is no doubt that Mathematics plays a major role in Security of individual and a nation in general. Mathematicians should therefore rise up and play a prominent role in solving the food and security problems in Nigeria.

Suggestions

The following suggestions were made:

- Government should continue to provide functional Mathematics education at all levels of education since it is paramount on security problems and provision of foods.
- Private sectors of the economy should employ people whereby reducing poverty, crime and insecurity problems.
- Government at all levels should encourage the use of CCTV systems in public places to reduce crime and security problems.
- Government should organize training for farmers in the field of Mathematics in order to acquire mathematical skills necessary to help them in their agricultural work for food security.
- A credit level pass in senior secondary school mathematics should be a sine qua non for recruitment into both the military and paramilitary organizations in the country.
- A significant number of graduates of mathematics and applied sciences should be enlisted into the nation's security manpower structure to elicit critical/logical reasoning.
- Senior and competent mathematics experts should be encouraged by government to conduct researches, the outcomes of which can assist Nigeria in combating the nation's food and security challenges.

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FACTORS INFLUENCING THE CHOICE OF TEACHING METHODS UTILIZED BY SECONDARY SCHOOL MATHEMATICS TEACHERS

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Abstract

This research investigated the factors influencing the choice of teaching methods utilized by Secondary School Mathematics Teachers. It was carried out in the government approved public secondary schools in Owerri Municipal Council Area of Imo State, Nigeria, with forty-four (44) Mathematics teachers as the sample of our study. Four research questions guided the study. A forty-three itemed questionnaire on a four-point Likert-type scale served as the instrument for data collection. Simple mean / averages was used to analyze the data collected. The study revealed that eight out of the nine tested teaching methods were utilized by the Secondary school Mathematics teachers while gender, years of teaching experience and educational qualification of the teachers affect their choice of teaching methods to varying degrees, the most significant factor being the teachers' qualification. Following our findings, we made recommendations that would ensure the use of more mathematics teaching methods.

Keywords: Teaching methods; Mathematics teaching; Secondary School; Teachers; Instructional Strategies.

Introduction

Education has been defined as the process of transferring to the next generation, the skills, attitudes, virtues, social understanding, values, habits and societal cultures so that they are prepared to seamlessly fit into and be productive in the society wherein they belong (González-Pérez, & Ramírez-Montoya, 2022). Parankimalil (2012) defined education as a systematic process through which a child or an adult acquires knowledge, experience, skill and sound attitude. Education is meant to develop the mind, not rote recall as John Dewey believed that teachers must balance an understanding of the habits, traits, and dispositions of individual children with an understanding of the means for arousing children's curiosity (Schmidt & Allsup, 2019). This means that educators should possess a humane and brilliant perception of how individual minds function in addition to being an adaptable subject matter expert (Haywood, 2020). Teachers, therefore must be masters in child developmental processes and thus adopt best practices to ensure that effective teaching and learning takes place (Niemi, 2021). Effective learning occurs as a result of effective teaching strategies, hence the need for use of teaching methods that ensure and enhance

functionality of the education received by the learners.

In Nigeria, the Universal Basic Education (UBE) system of education; 6 years of primary education, 6 years of secondary education (which is split into 3 years junior secondary and 3 years senior secondary), and 4 years of tertiary education is practiced. At the secondary school level a variety of subjects are taught based on the school curriculum. One of these special subjects is Mathematics and Mathematics education is very essential as it's crucial to the economic success of societies and also very crucial in the scientific and technological development of countries (Mazana, Suero, & Olifage, 2019). To understand other disciplines such as engineering, sciences, social sciences and even the arts, mathematics skills are required. Mathematics plays an important role in science and technology, outspreading its application to all areas of science, technology, and business enterprises, as explained by Abe and Gbenro (2014); this has made mathematics a key subject in school curriculum. Mathematics taught in schools therefore, must be applicable and relatable, enhancing the employability of the learners and improving their integrability into the modern society (Sullivan, 2011).

There are several teaching methods used in teaching mathematics, some of which include: the lecture method, which involves the teacher delivering the content through lectures while students take notes and listen attentively (Rapanta, Botturi, Goodyear, Guàrdia & Koole, 2020), the problem-solving approach, which focuses on presenting real-life problems that require mathematical solutions (Freiman & Fellus, 2021). Here, students are encouraged to actively engage in finding solutions, promoting critical thinking and application of mathematical concepts. There is the interactive teaching, a teaching method where teachers use various interactive techniques, such as group discussions, debates, and questioning sessions, to encourage student participation and foster a deeper understanding of mathematical principles (Yaseen & Farooq, 2023); visual aids and manipulatives, such as charts, graphs, diagrams, and manipulatives like blocks, geometrical shapes, or abacuses, are also employed to help students visualize abstract concepts and enhance their understanding (Dewantara, Setiawati, & Saraswati, 2023). Technology-integrated teaching involves incorporating technology, like computer software, educational apps, and graphing calculators, to make learning mathematics more interactive and enjoyable for students (Shurygin, Anisimova, Orazbekova, & Pronkin, 2023). There is also cooperative learning method, which involves group activities and projects, where students work together to solve mathematical problems, encouraging collaboration and peer learning (Klang, Karlsson, Kilborn, Eriksson, & Karlberg, 2021). Inquiry-based learning is a learning method where students are encouraged to explore mathematical concepts independently and discover solutions to problems through their inquiries and investigations (Dita, Utomo, & Sekar, 2021). There is also the game-based learning-where math-related games and puzzles are used to create an enjoyable learning experience while reinforcing mathematical concepts and problem-solving skills (Farmonov, & Karimova, 2023). The flipped classroom, which utilizes the approach where students study mathematical concepts independently at home through videos or readings, and classroom time is used for discussion, clarification, and practical application (Umam, Nusantara, Parta,

Hidayanto, & Mulyono, 2019) is also a mathematics teaching method and finally, the project-based learning, where students work on extended projects related to real-world situations, applying mathematical principles to find solutions, enhancing their problem-solving and analytical skills (Serin, 2023) is also an effective way of teaching mathematics.

The academic achievement of a learner can be influenced by a lot of factors which include but are not limited to the teaching methods of the facilitator (Mohamed & Alsayed, 2021), and this variable is the focal point of this study. Mathematics teaches the very important life skill of problem solving and so is mandatory for every child (Peranginangin & Siagian, 2019). Given that this is a non-negotiable skill for daily survival, the methods and styles used in the impartation of this knowledge in schools is non-trivial. The quality of this education is directly related to the quality of the teacher (Abduliahi & Onasanya, 2010). By this opinion, it can be inferred that the effective implementation of robust educational policies is more to be desired than the mere formulation of such, and it is the teacher who will eventually bring these theories to reality. Thus, Mathematics education largely depends on the overall preparedness of the teacher – their understanding of the subject matter, its' nature and the teaching methods to be employed by them (Rajakumar, 2006). Where a substantial amount of teaching methods cannot be utilized by a teacher (or even an improper use of same), this can be interpreted to mean that the teacher lacks the ability to relate the subject matter to real life experiences. This ultimately results in the students feeling aloof and not being able to link Mathematics with other sciences and fields of learning. The method of teaching adopted by the teacher thus plays a large part in determining the extent of achievement of these goals. The above observation urgently craves investigation to ascertain the various teaching methods utilized by teachers in teaching Mathematics in secondary schools. Incidentally, none of such studies has been carried out in Owerri Municipal Council of Imo State and this is the focus of this study. This study is designed to find out the teaching methods adopted by these secondary school mathematics teachers and the factors that influence those choices.

1.2 Purpose of the Study

The main purpose of this study was to investigate what teaching methods and the factors which influence the teaching methods employed by teachers of mathematics in secondary schools in Owerri Municipal Council Area.

1.3 Research Questions

The following research questions/ hypotheses were adopted for this study:

1. What are the teaching methods used by teachers in the teaching of Mathematics in secondary schools?
2. To what extent does gender of the teacher influence the teaching methods presently used by secondary school mathematics teachers?
3. To what extent do years of teachers' experience influence the teaching methods used in teaching and learning of Mathematics?
4. To what extent does teacher qualification influence the teaching methods used by secondary school mathematics teachers?

1.4 Limitation

This study was delimited to Secondary schools in Owerri Municipal Council of Imo State in Nigeria, focusing on teachers of Mathematics. This study considered the teaching methods utilized by secondary school mathematics teachers in the teaching and learning of mathematics; determining whether gender, years of experience and teacher qualification influence the methods utilized by teachers of Mathematics in the area under study. This study is significant because it investigates the actual teaching methods adopted by the mathematics teachers in the selected schools in Imo state, Nigeria, the actual factors influencing these choices and the findings will be compared with those from previous studies in literature. The reports from this will be highly beneficial to the education management board and the education policy makers, given the peculiarities of the educational system in Nigeria and the lacklustre attitude towards education in general.

2.0 LITERATURE REVIEW

Teacher competence can be attributed to teacher age, educational qualification, professional

certification, gender, years of teaching experience and so on (Hartlep & McCubbins, 2013; Wu, Zhou, Li & Chen, 2022; Cattaneo, Antonietti & Rausedo, 2022). It is argued that teacher experience enhances their efficiency, leading to older and more experienced tutors being more efficient at teaching than their younger, less experienced counterparts. Howbeit, literature shows little correlation between teacher competence and experience/age, a part of which comes from self-development efforts (Rezaeian, & Abdollahzadeh, 2020; Bhattacharjee, 2022). Another submission relates teacher efficacy directly to their experience and the acquisition of an advanced degree, even though this view is not supported by the findings of Tribble (2020) which suggests that teachers who have obtained a master's degree were not more competent than those without any, in the classroom. This is not to trivialize the importance of acquiring advanced degrees.

Manullang (2005) in his paper attempted to find a correlation between known variables (teachers' educational level, teaching experience, teachers training, professional attitude, quality of teaching and learning interaction) in relation to the development and improvement of the quality of teaching and learning interaction for the 34 mathematics teachers in Dairi Regency, North Sumatra, Indonesia. Results showed significant correlation between the variables indicated. Tweed (2013) set out to ascertain how teacher age, professional development, years of teaching and self-efficacy drove the use and implementation of modern teaching technologies. The result showed that the first three factors were insignificant in classroom technology utilization by teachers, while the last factor gave a positively significant correlation. Pressley, & Rangel, (2023), observed that educators within their first year of teaching recorded remarkably lower competence in the use of various instructional strategies and classroom coordination than did their professionally older colleagues. It was also observed that lesser-experienced teachers were more amenable to change and update in their personal teaching styles and beliefs than the more experienced teachers (Rahimi & Asadollahi, 2012). Rahimi & Asadollahi (2012), also returned mixed reports that indicated that

whilst pre-service teachers have a preference for incorporating newer instructional methods, the more experienced ones worried more about instructional organization and classroom management and how these affect the students.

The Mathematics curriculum recommends that Mathematics be taught using a variety of instructional methods. The study of Choe & Hwang (2007), revealed that 77.3% teachers taught by explanation, 11.8% preferred small group activities while 8.2% preferred student presentations and demonstrations. Toropova, Myrberg, & Johansson (2021), opined that the age of a teacher is not a contributory factor to their efficacy. The research conducted by Tweed in (2013) delved into the intricate dynamics between gender, age, and personality style in the context of technology implementation by university professors. By analyzing these aspects, the study sought to gain insights into the factors that could either facilitate or hinder the adoption of technology in higher education, providing a deeper understanding of the overall digital transformation in the academic environment. The results supported Dewey's theory (1938) that older professors used more technology than the younger faculty members. Tweed (2013) alluded this outcome to the fact that the professors having also taught the content over time were more comfortable and so could take more time to design better teaching and learning experiences with modern technology.

A vital factor which might influence teachers' preferences in terms of their choice of teaching methods is gender. The dominance of a particular gender, particularly the male, in addition to societal relations play a role here (Rahimi & Asadollahi, 2012; Perryman & Calvert, 2020). There is usually an unspoken code that female professionals cannot lead in a mixed gender setting, and so the females are subtly marginalized in favour of their male counterparts in such educational environments (Rahimi & Asadollahi, 2012). The study of Marbán & Mulenga (2019), suggests that gender influences teaching methods adopted by teachers. While majority of these studies recorded higher teacher self-efficacy in females than in males (Shaukat, Vishnumolakala, & Al Bustami, 2019), others found no gender-based difference in self-efficacy of teachers (Rani & Jain, 2023; Gul, Khan, & Hassan, 2018). A

statistically insignificant correlation was herein seen between teacher self-efficacy and age. Also, revealed was a weak, positive relationship between years of teaching experience and teacher self-efficacy scores and a correlation that was not statistically significant. In Anbuthasan & Balakrishnan (2013), a sample of 300 teachers in Tamilnadu state were surveyed and results revealed that women teachers were remarkably more efficient in teaching than the men, whereas their age groups didn't matter.

In their study, Abu & Fabunmi (2009) examined how the academic performance of adult learners in a part-time programme of the University of Ibadan in Nigeria were influenced by the teacher's experience, age, qualification and the teacher-learner ratio. All the variables reported significant positive correlation and so the article advocated for team teaching by lecturers. Rotumoi & Too (2012) stated that "Teachers' qualifications play an important role in teaching because they influence instructional competence and may also determine the existence of instructional problems in the classroom context". Kimani et al. (2013) studied the relationship between some teachers' teaching practices with respect to their demographics and their students' academic performances in a few secondary schools in Kenya. This study revealed that neither the teachers' gender, teaching experience, age nor qualifications affected the students' achievement academically. Rahimi & Asadollahi (2012) also undertook a related study by randomly selecting 300 EFL teachers in Tehran. The reports showed that in as much as the female and male teachers had different teaching styles, the teacher's experience and age did not positively correlate to it. Therefore, teaching styles vary from teacher to teacher and all the styles differ in their individual effectiveness (Rahimi & Asadollahi, 2012).

Over recent years, concerns about mathematics underachievement and, by implication, mathematics teaching has loomed larger than ever in educational discourses across the world. Contemporary thinking about teaching is based around the idea that teachers are responsible for students' lack of proficiency. Many national policies have continued to examine how students learning are impacted by 'ineffective' teaching especially in Mathematics, stressing that young peoples' inability to perform well in

Mathematics is partly as a result of the incompetence of the teachers. But a new educational policy does not automatically transform to effective teaching. Therefore, the emphasis should be on ensuring that the teachers, who are the final executors of this learning process, possess the right skills, knowledge and attitudes needed to transfer this knowledge to the mathematics learners (Anthony &Walshaw, 2007) in (Walshaw, 2012). In this work, survey has been carried out to ascertain some of the teaching methods currently used by secondary school mathematics teachers in Owerri Municipal Local Government Area of Imo state and some of the factors that affect their use.

3.0 METHODOLOGY

Descriptive designs are used for the type of research where the researcher only observes and describes events without any manipulation or

treatment. These include surveys, case studies, historical studies, etc. This research study is of a descriptive type. Sample survey was utilized in gathering data used in the testing of hypotheses and to answer research questions concerning the current position of the subject matter. It took about three (3) weeks to collect complete data from all respondents sampled. The geographical area under consideration is the Owerri Municipal Council of Imo State, Nigeria. Owerri Municipal Council is one of the twenty-seven (27) local government areas that make up Imo state, with its headquarters as the city of Owerri. The population of this study was drawn from all the Mathematics teachers in the nine (9) government approved secondary schools in Owerri Municipal Council of Imo State, see Table 1. Emphasis was on the teaching methods utilized by the mathematics teachers in teaching and learning of mathematics in these secondary schools.

S/N	NAME OF SCHOOL	LOCATION OF SCHOOL	NUMBER OF MATHEMATICS TEACHERS	NUMBER OF STUDENTS
1	Boys Secondary School New Owerri	New Owerri	01	1537
2	City College Owerri	Wetheral	06	1081
3	Comprehensive Development Secondary School	Douglas Road	04	3688
4	Emmanuel College Owerri	Douglas Road	06	1314
5	Government Secondary School Owerri	Okigwe Road	09	2761
6	Government Technical College	Egbu Road	06	3841
7	Ikenegbu Girls' Secondary School	Ikenegbu	07	4029
8	Urban Development Secondary School	New Owerri	04	1920
9	Young Scientists College Owerri	Owerri	01	179
	TOTAL		044	20350

Table 1 Government Approved Public Secondary schools in Owerri Municipal L.G.A. in Imo State.

SOURCE: Planning, Research and Statistics Department, Secondary Education Management Board (SEMB), State Ministry of Education, Owerri, Imo State.

The sample population for this study, comprises all the Mathematics teachers in all the approved public secondary schools. This gave a total sample size of 44 (forty-four) Mathematics teachers, making a total of 44 respondents. The use of all the Mathematics teachers in a particular sample school (i.e. both the

mathematics teachers for the senior (18) and junior classes (26) in each secondary school) guaranteed an all-encompassing survey for this study to yield useful results.

The use of structured questionnaire was employed as the primary instrument for data collection. Data thus gathered is numerical in nature. The designed questionnaire was based on the purpose of this study, and the research questions were enumerated and designed for teachers. The questionnaire was self-made and divided into two sections: section A was used to gather personal information of each respondent (biodata) while section B was structured in likert scale to address the research questions of the teachers' classroom teaching methods. The questionnaire was validated by Mathematics subject specialists, and Measurement and evaluation experts to ascertain its' face validity and suitability (content validity).

The structured questionnaires were distributed to the mathematics teachers and were collected

back on the spot. In some instances, the researchers explained the goals of the research to the teachers to guide their responses to be accurate. If any of the mathematics teachers was not available to immediately fill out the questionnaires, the researcher had to repeat the visit at another day or wait for the teacher to be free. The questionnaires were neither mailed, collected nor returned by proxy to ensure 100% return of the instrument and that the instrument was filled out by the intended person, to avoid sabotaging the research findings. The consent of the school authorities and Mathematics teachers were sought for and obtained before the administration of the instrument. Section B was designed as a four-point likert scale with the following weights:

Extensively Used (EU)	-	4 points
Frequently Used (FU)	-	3 points
Rarely Used (RU)	-	2 points
Never Used (NU)	-	1 point

The average score shall be calculated thus: $\left(\frac{4+3+2+1}{4}\right) = \left(\frac{10}{4}\right) = 2.5$ points

A mean score of 2.5 was adopted as the cut-off point i.e. the agreement level for each item. Using this mean score of 2.5, any mean score below 2.5 was regarded as 'Not Used' while any mean score of 2.5 and above was regarded as 'Used'. For the analyses of data collected, the methods of descriptive analysis were utilized. The frequency table and mean simple percentages was used to analyze all the data collected from the respondents. Nine mathematics teaching methods were tested. These methods are lecture, cooperative learning, guided discovery, project, exposition/explanation, discussion, problem-solving, laboratory approach and games.

4.0 RESULTS & DISCUSSIONS

Investigation on the factors influencing the choice of teaching methods utilized by Secondary School Mathematics Teachers in the Owerri Municipal council was carried out. Forty-four (44) Mathematics teachers in the nine (9) government approved secondary schools in Owerri Municipal Council of Imo State were sampled and the results are presented.

4.1 Research Question One:

What are the teaching methods used by Mathematics teachers in the teaching of Mathematics in secondary schools? The findings are displayed in Table 1 below.

QUESTIONNAIRE ITEMS	EU	FU	RU	NU	n	EX	(EX)/n	POOLED MEAN
ACTIVITY-BASED (GAMES)								
Learners are presented with play items to arouse their interest in the topic.	5	18	15	6	44	110	2.50	2.68
Learners engage in games, designed by the teacher to teach a topic.	3	11	28	2	44	103	2.34	
I provide mathematics games for students to practice basic algebraic skills.	4	15	22	3	44	108	2.45	
I illustrate mathematical concepts for students with pictures.	6	31	7	0	44	131	2.98	
I have students use cubes, blocks or other models to represent mathematical concepts.	14	22	8	0	44	138	3.14	
PROBLEM-SOLVING								
I have students create their own equations in a new problem situation	4	22	15	3	44	115	2.61	3.09
I create problems from the interests of individual students.	10	28	5	1	44	135	3.07	
I draw mathematical concepts from real-life situations.	18	24	2	0	44	148	3.36	
I have students pursue open -ended and extended problem-solving projects.	8	20	14	2	44	122	2.77	
I emphasize the problem -solving procedure rather than obtaining the solution.	22	17	3	2	44	147	3.34	
I anchor the problem -solving skills instruction within situations meaningful to the students.	15	24	5	0	44	142	3.23	
I encourage students to experiment with alternative methods for problem-solving.	14	26	4	0	44	142	3.23	
LECTURE METHOD								
I identify a new skill l or concept at the beginning of instruction and provide a rationale for learning it.	8	30	5	1	44	133	3.02	3.07
I provide a gradual sequence of instruction, moving students from concrete to abstract concepts in defined steps.	15	24	4	1	44	141	3.20	
I use pre -worked examples to introduce or reinforce topics	15	20	7	2	44	136	3.09	
The learner mostly listens while I talk more during instruction	9	19	13	3	44	122	2.77	
I do not use illustrations and models during the lesson period to teach.	4	10	4	26	44	140	3.18	
There is steady flow of information from the teacher to the students.	19	20	4	1	44	145	3.30	
Questions from the learners may be entertained for clarification and not for discussion.	10	24	6	4	44	128	2.91	

DISCUSSION METHOD								
I encourage students to use math vocabulary terms in class discussions.	20	22	2	0	44	150	3.41	3.35
I have students describe their thought processes orally or in writing during a lesson period	13	27	4	0	44	141	3.20	
I require students to share their thinking by conjecturing, arguing and justifying ideas.	13	24	7	0	44	138	3.14	
I encourage students to ask questions when difficulties or misunderstandings arise.	28	16	0	0	44	160	3.64	
I encourage students to explain the reasoning behind their ideas.	16	27	1	0	44	147	3.34	
I use instructional materials to help students with comprehension.	18	20	5	1	44	143	3.25	
There is intelligent exchange of ideas between students and between students and their teachers	22	22	0	0	44	154	3.50	
CO-OPERATIVE LEARNING								
I collaborate with the whole class in finding a solution to a problem.	21	19	2	2	44	147	3.34	3.02
I allow students to engage in cooperative problem-solving.	15	28	1	0	44	146	3.32	
I allow students to discuss solutions to problems with their peers.	14	28	2	0	44	144	3.27	
I allow students to begin homework in class with peer assistance.	11	19	8	6	44	123	2.80	
I pair students to work as peer tutors.	9	19	13	3	44	122	2.77	
I reward group performance in the cooperative setting.	10	20	12	2	44	126	2.86	
I assign students to work in homogenous and heterogeneous groups.	10	16	15	3	44	121	2.75	
EXPOSITION / EXPLANATION								
I use simple terminologies to explain new concepts.	28	16	0	0	44	160	3.64	3.51
I make each concept comprehensible to the students.	22	19	3	0	44	151	3.43	
I give reasons or make justification to students for every action taken in the problem solution process during the lesson.	21	22	1	0	44	152	3.45	
PROJECT METHOD								
Students are given topics to research on and make presentation of their findings.	6	17	18	3	44	114	2.59	2.86
Students source for information on a lesson topic.	6	22	15	1	44	121	2.75	
Students are encouraged to use their initiative and to reason.	18	19	7	0	44	143	3.25	

DISCOVERY METHOD								
Students find out things by themselves.	7	11	23	3	44	110	2.50	2.55
Students form concepts or come to conclusions themselves about a phenomenon.	5	11	23	5	44	104	2.36	
Learners have direct experience with the objects in the environment which gives them information.	9	18	16	1	44	123	2.80	
LABORATORY (PRACTICAL) METHOD								
Students carry out practical sessions in the laboratory.	0	11	7	26	44	73	1.66	1.66

Table 2: Table of Research Question One responses
SOURCE: Adapted from Hass, Matthew Steven (2002)

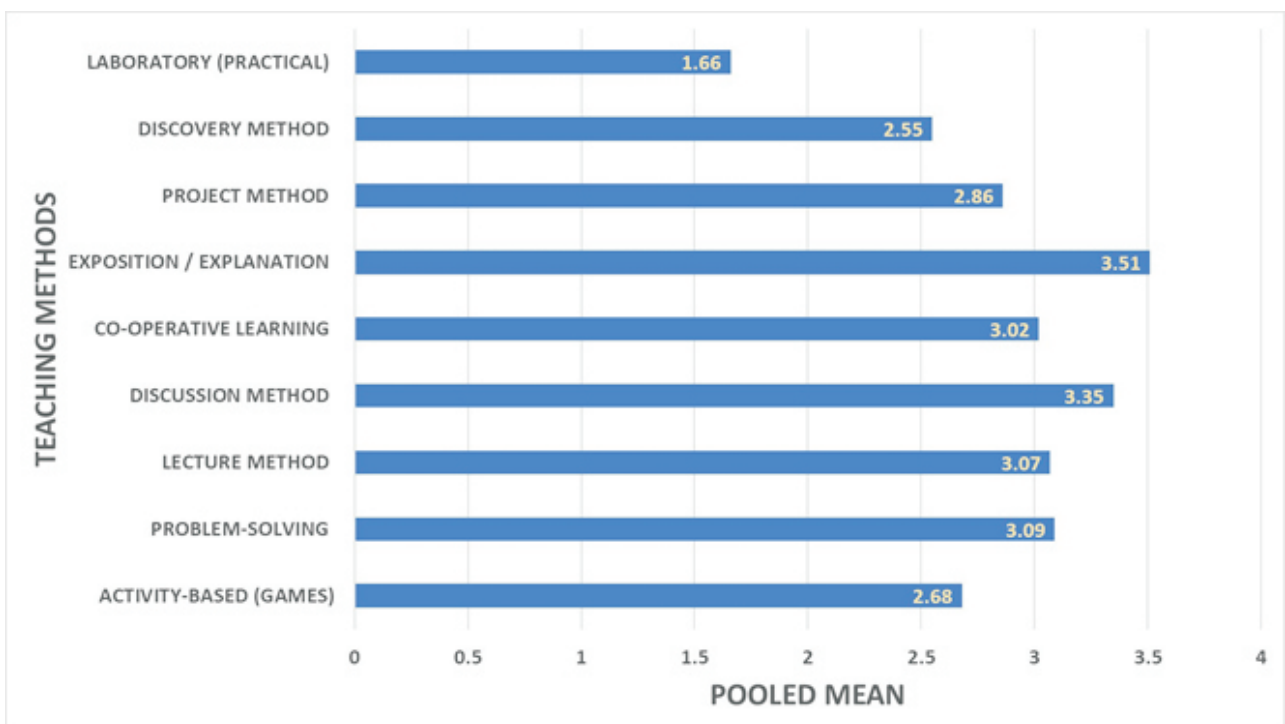


Fig. 1 Bar Graph of Research Question One responses

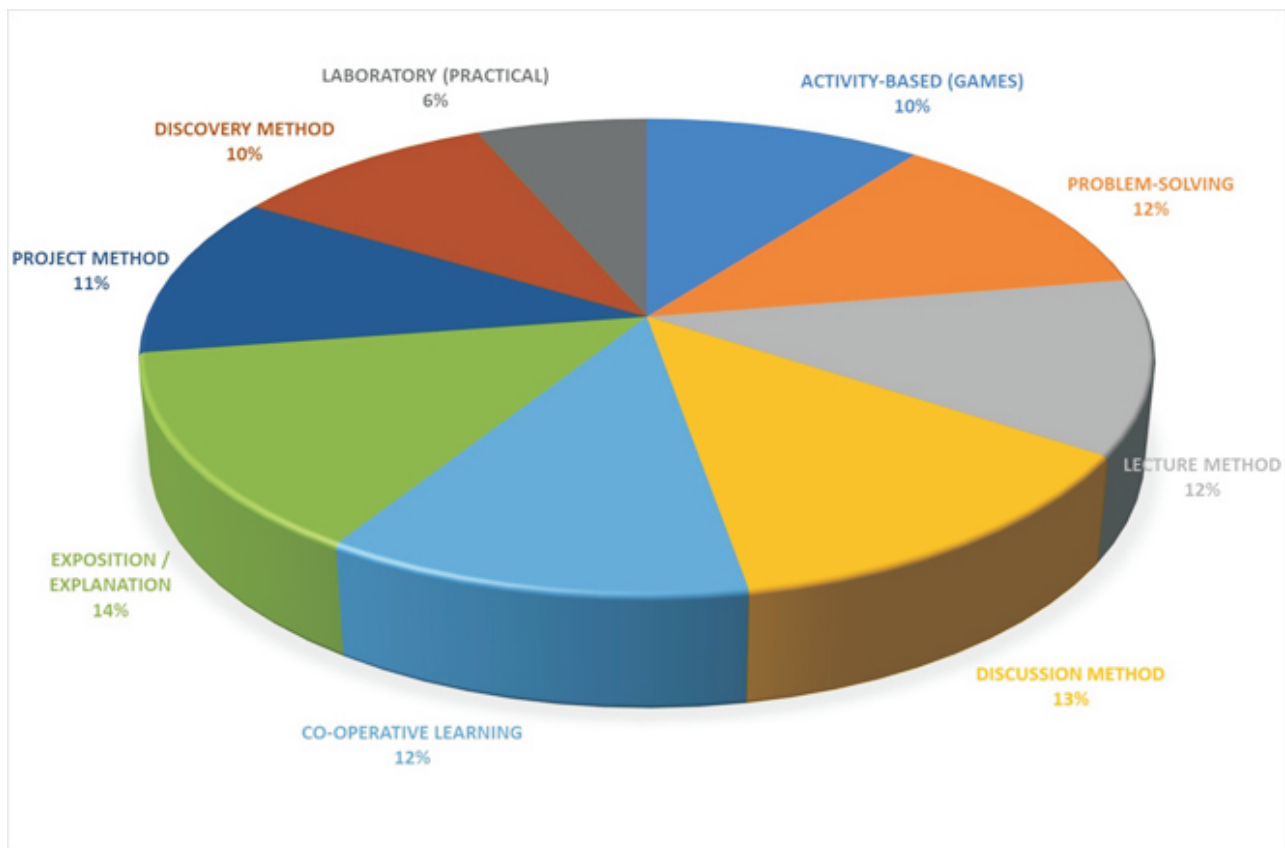


Fig. 2 Pie Chart of Research Question One responses in percentages

Based on the data collected and having an average acceptance mark of 2.5, the use or not of various teaching methods was analysed and the outcomes varied, returning positive and negative results for different teaching methods. The results obtained is presented in Table 2 and illustrated in Fig. 1. The results show that eight of the nine teaching methods being tested are actively being used by secondary school Mathematics teachers in teaching Mathematics in Secondary schools in Owerri Municipal Council of Imo State. The laboratory (practical) method which has a pooled mean of 1.66 returned a negative decision, which signifies that it is not implemented in the Mathematics teaching.

The frequency of use of each of these teaching methods can be further ascertained upon closer inspection of the data. Activity (Games), Project and Discovery methods were the least used of the eight teaching methods in use, while problem-solving, lecture, discussion, co-operative learning and exposition/explanation methods are more frequently used. For an

enhanced visual representation of results, Fig. 2 is provided. It can be clearly seen that the exposition / explanation method is the most widely implemented teaching method, constituting 14% of total methods usage, while the discovery method with just 10% of the overall usage is the least used.

Following insights from our analysis therefore, general conclusions can be made. Other than the Laboratory/Practical method with a negative pooled mean, it is apparent that all eight other teaching methods are actively employed by secondary school Mathematics teachers in Owerri Municipal Council. The discovery method is least favoured by the sampled teachers while the exposition/explanation method is the most favoured teaching method. This notion is supported by the data collected from the sampled teachers.

4.2 Research Question Two:

To what extent does sex (gender) of the teacher influence the teaching methods presently used by secondary school mathematics teachers?

METHODS	MALES	FEMALES
ACTIVITY-BASED (GAMES)	2.66	2.70
PROBLEM-SOLVING	3.13	3.04
LECTURE	3.15	2.97
DISCUSSION	3.39	3.33
CO-OPERATIVE LEARNING	3.06	2.97
EXPOSITION / EXPLANATION	3.51	3.50
PROJECT	2.94	2.77
DISCOVERY	2.72	2.35
LABORATORY (PRACTICAL)	2.00	1.25

Table 3: Summary of Research Question Two responses

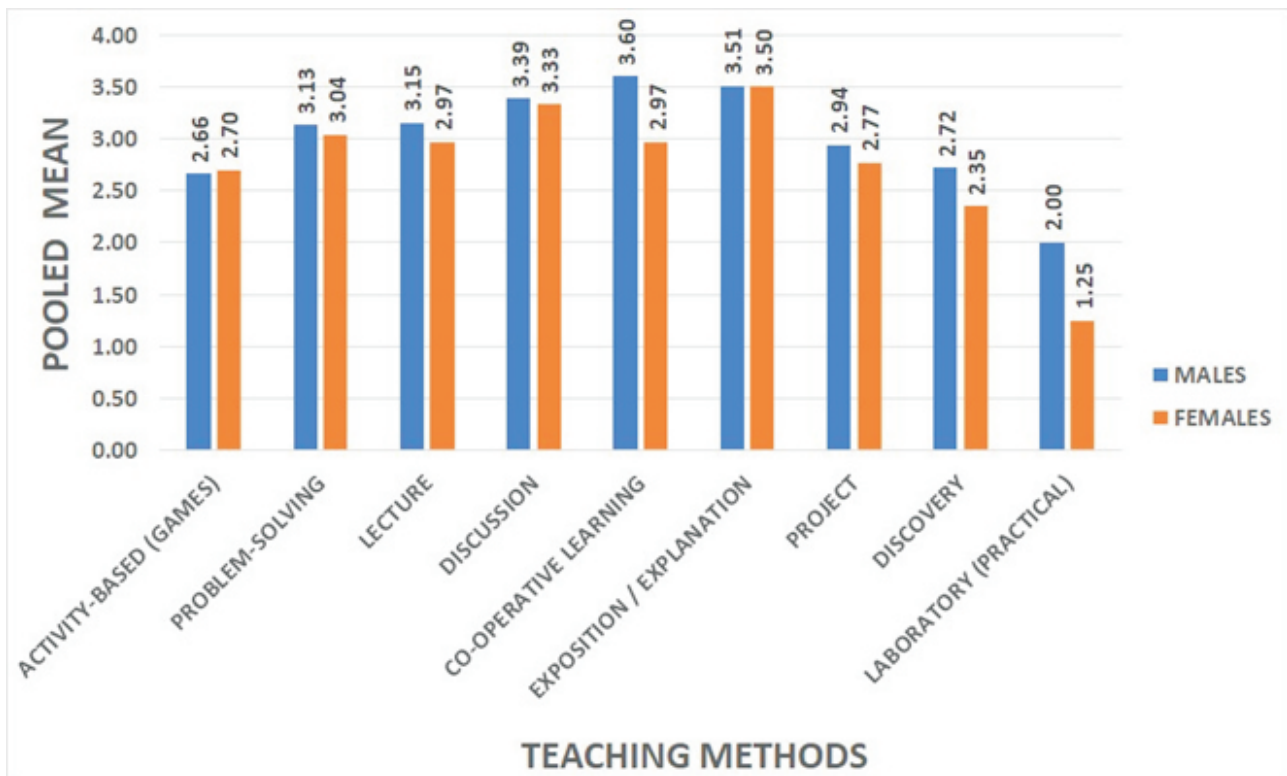


Fig. 3 Bar chart of Research Question 2 responses grouped by teaching methods

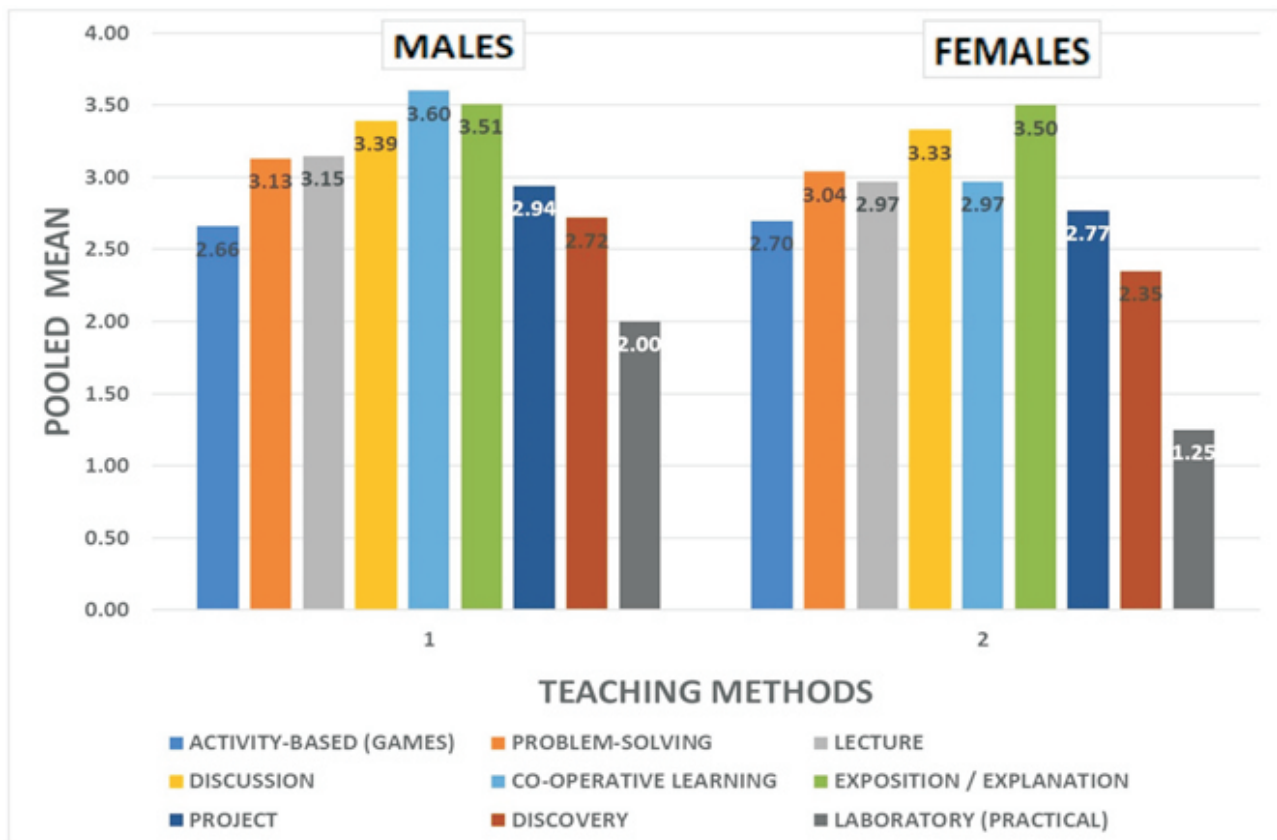


Fig. 4 Bar chart of Research Question 2 responses grouped by Gender

An analysis of the results obtained, and which is displayed in Table 3, reveals the utilization of varied teaching methods by the secondary school Mathematics teachers, on the basis of their gender. Fig. 3 provides insight into the patterns and disparities displayed by the female and male teachers in their choice of implementation of teaching methods. Of the nine methods investigated, seven of the teaching methods (activity-based/games, problem-solving, lecture, discussion, co-operative learning, exposition/explanation and project) are used by both sexes to almost the same extent. This connotes a good parity level in the pedagogical styles of both gender. In contrast, a very significant deviation is exhibited by the discovery method. Results indicate that the male teachers use the discovery method more frequently than their female counterparts. Based on the pooled mean, the decision on the use of the discovery method by the male Mathematics teachers is positive while it is negative for the female teachers.

Again, even though the male teachers use the laboratory method (2.00) least, they still use it

more than the female teachers (1.25). Nevertheless, based on the pooled mean, the decision on the use of the laboratory method by the Mathematics teachers is negative for both sexes. It is obvious that this method is not amenable to use by both gender, despite their trying to incorporate it at minimal levels. Among the seven methods in use, the pooled-mean values are higher, even slightly, for the male gender in all except for the activity-based method. It is further observed from Fig.4 that the most used method for the males is the co-operative learning method whereas for the females, it is the exposition/explanation method. In summary, the use of teaching methods irrespective of the gender of the Mathematics teachers corresponded in eight out of the nine teaching methods tested (88.89%). This is a very substantial alignment in patterns for both genders. Hence, the gender of the teachers influences the teaching methods used by Secondary School Mathematics Teachers by 11.11%, with the males having higher competence. It can be inferred from this variation, and also from the slightly higher

values of the male gender in all the other methods, that the males are more comfortable and adept at utilizing these teaching methods than their female counterparts.

4.3 Research Question Three:

To what extent do years of teachers' teaching experience influence the use of teaching methods in teaching of Mathematics?

METHODS	GRPA 1-5 YRS	GRP B 6-10 YRS	GRP C 11-15 YRS	GRP D 16-20 YRS	GRP E 21 YRS AND ABOVE
ACTIVITY-BASED (GAMES)	2.67	2.60	2.65	2.76	2.80
PROBLEM-SOLVING	3.02	3.11	3.21	3.08	3.00
LECTURE	3.12	2.97	3.29	3.05	2.83
DISCUSSION	3.33	3.37	3.48	3.30	3.37
CO-OPERATIVE LEARNING	2.89	2.96	3.20	3.03	3.14
EXPOSITION / EXPLANATION	3.50	3.43	3.71	3.52	3.33
PROJECT	2.75	3.00	2.96	2.67	3.07
DISCOVERY	2.64	2.67	2.50	2.22	2.80
LABORATORY (PRACTICAL)	1.50	1.80	1.63	1.56	2.00

Table 4: Summary of Research Question Three responses

The years of teaching experience of the teachers are grouped into five (5) as follows; Group A is 1-5 years, Group B is 6-10 years, Group C is 11-

15 years, Group D is 16-20 years and Group E is 21 or more years of teaching experience. The results are shown in Table 4, Figs. 5 and 6.

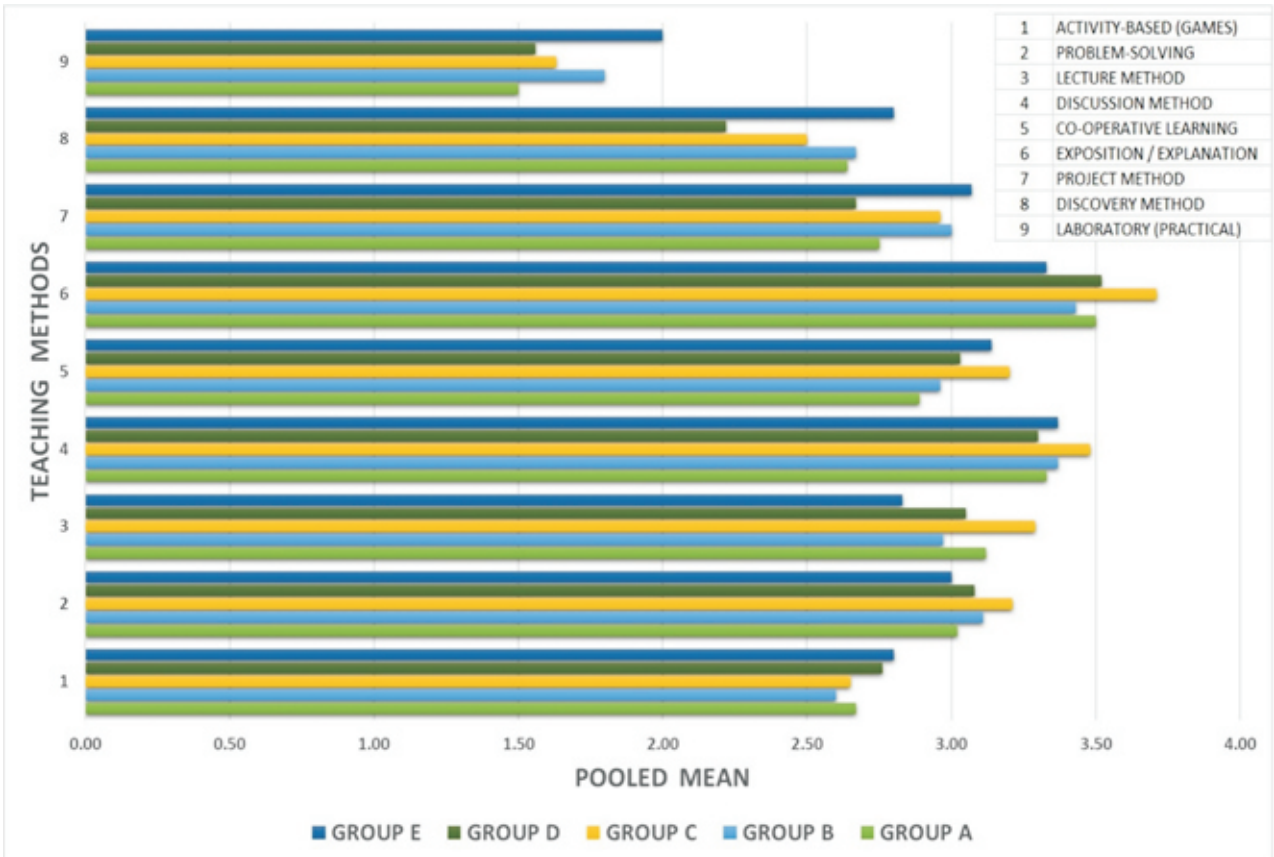


Fig. 5 Bar chart of Research Question 3 responses grouped by teaching methods

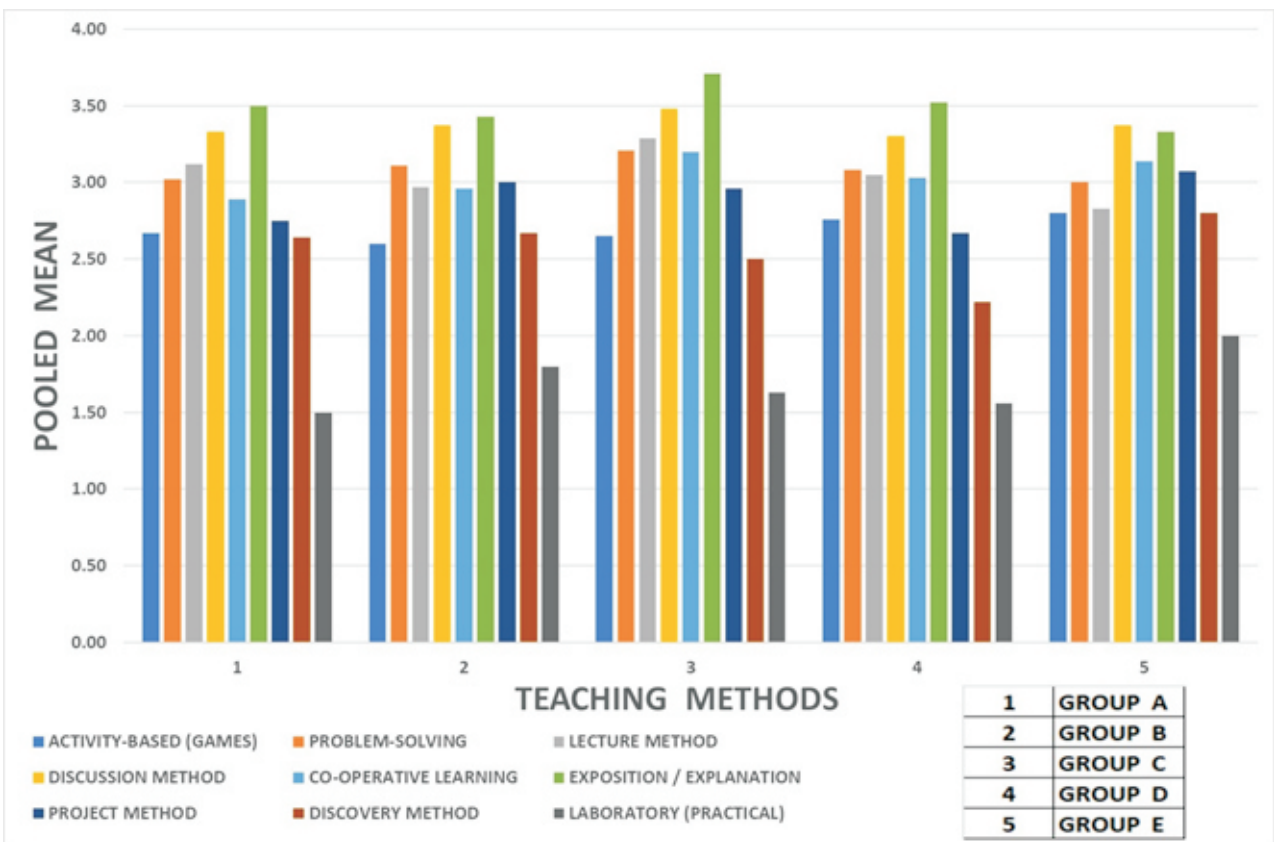


Fig. 6 Bar chart of Research Question 3 responses grouped by years of teaching experience

Considering 2.5 as the acceptable mark for making a positive decision, the data curated investigated the impact of the years of a teachers' teaching experience on their preference for certain teaching methods. Fig.5 reveals that all the different groups are positively inclined towards the first seven (7) methods listed, and also all negatively decided for the last method listed (that is, the laboratory method). This trend is seen to be a unanimous consensus across all the various groups of teachers. However, a disparity is observed with regards to the Discovery method. The group D shows a negative decision to the use of this method of teaching while the other groups are all disposed positively. This is a very minimal discrepancy in one out of nine methods (11.11%), though not trivial.

Furthermore, the exposition/explanation and the

discussion methods are the predominantly used methods and this holds true for all the groups (see Fig.6). These methods are apparently most preferred and thus seemingly very efficient in the teaching of Mathematics.

It can be summarized therefore, that the years of teaching experience of the Mathematics teachers affects their choice of teaching methods by 2.22% (i.e. one fifth of 11.11% discrepancy observed) and this is an insignificant percentage. Hence, the overall impact of the teachers' years of teaching experience on the choice of teaching methods utilized is very negligible.

4.4 Research Question Four:

To what extent does teacher qualification influence the teaching methods used by secondary school mathematics teachers?

METHODS	GRPA (NCE)	GRPB (B.Sc., B.Ed., PGD)	GRPC (M.Ed., M.Sc., Ph.D.)
ACTIVITY-BASED (GAMES)	2.20	2.72	2.62
PROBLEM-SOLVING	2.86	3.10	3.07
LECTURE	2.71	3.06	3.13
DISCUSSION	2.86	3.35	3.43
CO-OPERATIVE LEARNING	2.86	3.05	2.91
EXPOSITION / EXPLANATION	3.33	3.46	3.67
PROJECT	2.00	2.89	2.87
DISCOVERY	2.00	2.55	2.63
LABORATORY (PRACTICAL)	1.00	1.64	1.80

Table 5: Summary of Research Question Four responses

Teachers were grouped into three (3) based on their qualifications; Group A are teachers with NCE only, Group B are those with B.Sc., B.Ed. and/or PGDE, and lastly Group C are those

teachers with M.Sc., M.Ed. and/or Ph.D. The summary of the responses is presented in Table 5, Fig.7 and Fig. 8.

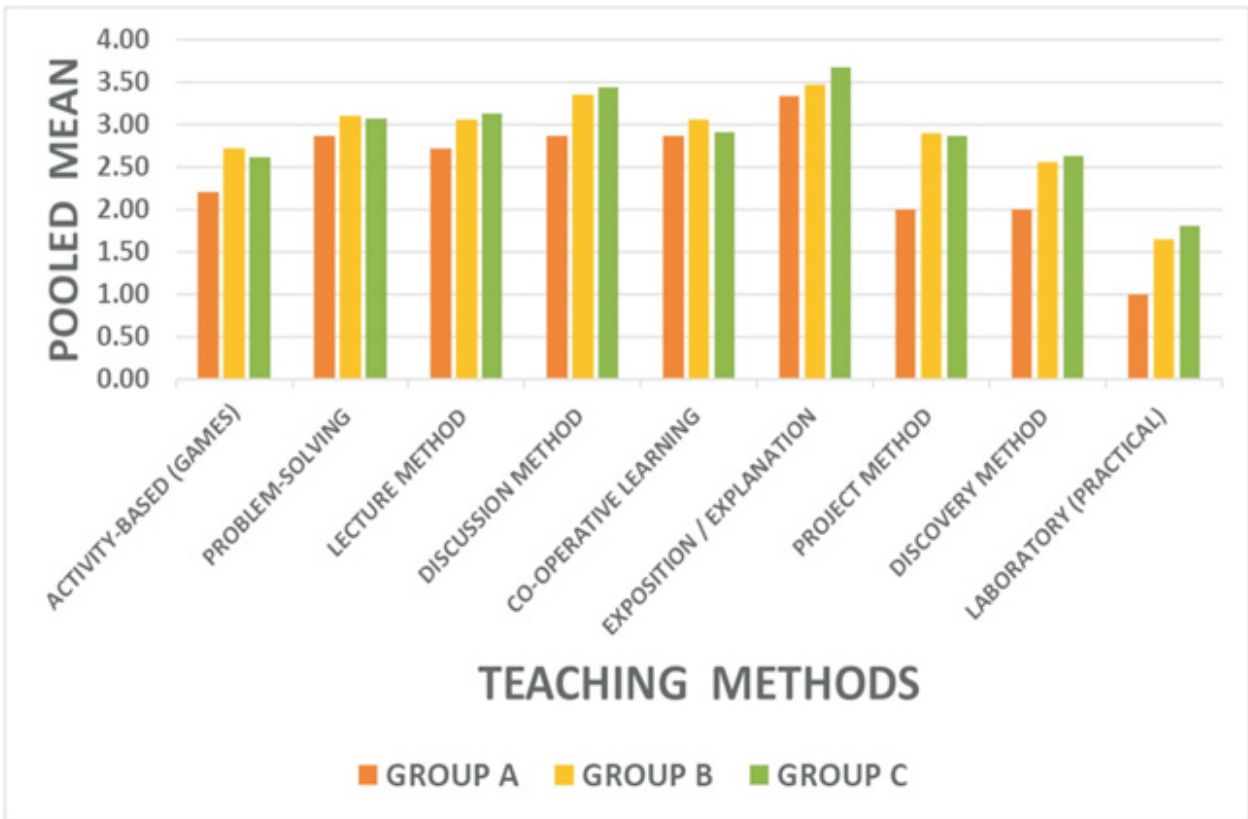


Fig. 7 Bar chart of Research Question 4 responses grouped by teaching methods

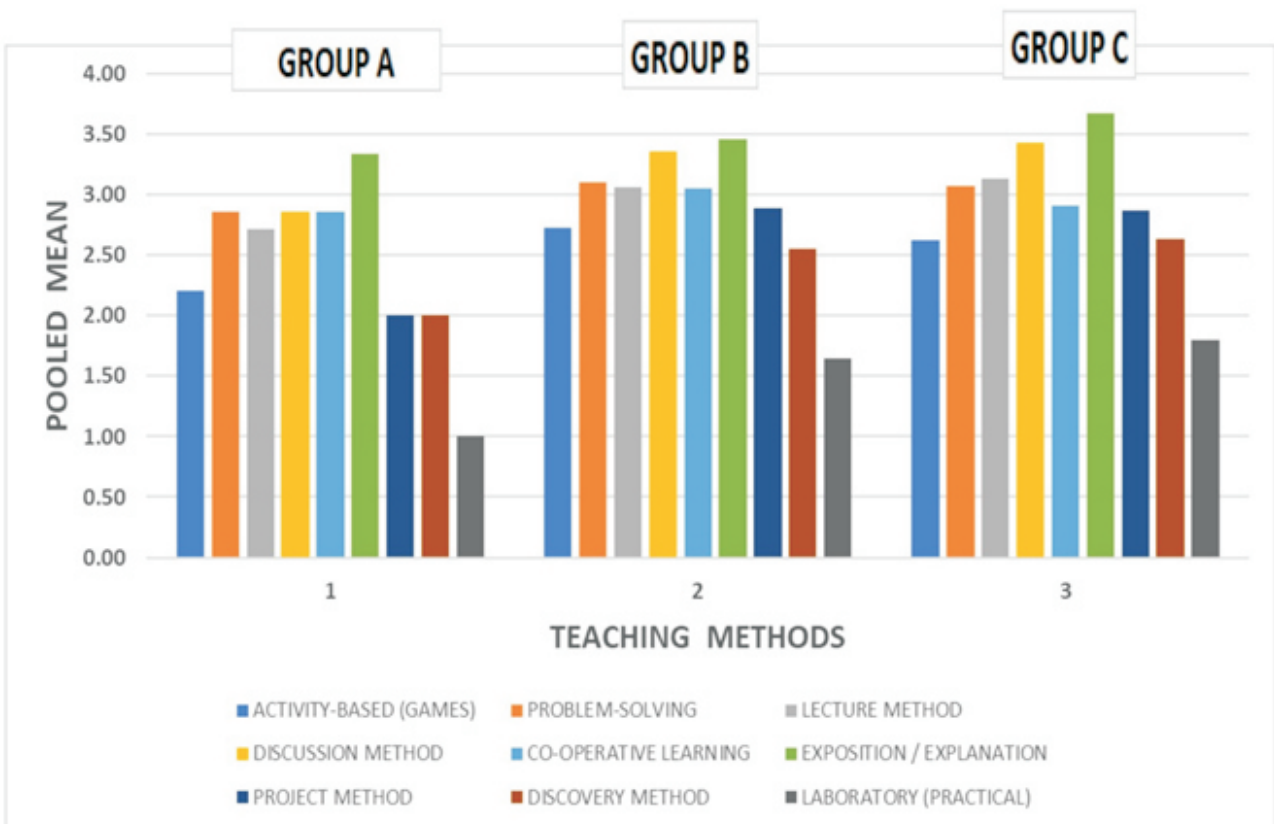


Fig. 8 Bar chart of Research Question 4 responses grouped by teacher's qualification

The adoption of teaching methods by educators based on their educational qualifications is herein investigated. An attempt is made to draw a relationship from these criteria. The data obtained is presented in Table 5.

Considering Fig. 7, it can be observed that the chances (pooled mean) of use of any of the methods increased as we moved from Group A to Group B teachers, and then increased (decreased) in Group C for teacher-centred (learner-centred) methods. This is expected, given that the teachers here interviewed are secondary school mathematics teachers who tend to adopt more of learner-centred methods, as against the more certified ones who prefer teacher-centred methods.

Looking at insights from Fig.8, the decision is positive for five (5) out of the nine methods for group A which has the least qualifications, while it is positive for eight (8) out of nine methods for groups B and C, which possess higher certifications. It is therefore clearly obvious and so can be inferred, that the more educational qualification a teacher possesses, the more teaching methods that teacher is proficient at and can utilize in teaching Mathematics.

The decision is negative for all groups in the Laboratory method. This shows that this teaching method is very unpopular, irrespective of the teachers' educational attainment. Consider again the non-use of the laboratory method for groups B and C; group C has a 1.80 chance of using the method as against the 1.64 chance for group B. Group A which possesses the least qualification has a 1.00 chance of using it. This goes to portray the fact that increased qualification of the Mathematics teachers encourages the use of more teaching methods, this propensity to try out more extensive methods encompasses even the methods that are less commonly used. With a general agreement in six (6) out of the nine (9) methods tested, it can be summarized that the teachers' qualification influences the choice of teaching methods adopted by 33.33%. Thus, educational certification of a teachers plays an important role in their adaptability to a broader range of teaching methods, which ultimately fosters better learning outcomes for the students.

4.5 Discussion of Findings

This study sought to obtain empirical evidence on the teaching methods and factors affecting

teaching methods utilized by secondary school Mathematics teachers in teaching Mathematics in Owerri Municipal Council of Imo State. The data collated are presented in Tables 2-5, while the findings and observations are described below.

From Fig. 1, the teachers' responses indicated that of all nine methods being tested, eight are in use while the laboratory method is not used. Among these eight that are in use, the discovery method is the least used (10%) while the Exposition/Explanation method is the most used (14%). This preference of use for certain methods over others by these teachers can be alluded to either the teachers' proficiency at using these methods over the others, or to the better effectiveness of those methods in the teaching of Mathematics or both.

From Fig. 4, the study also showed that the gender of the Mathematics teachers affected the teaching methods used by the Secondary School Mathematics Teachers by 11.11% with the male gender showing higher competence. This result aligns with the findings of a prior study conducted by El-Emadi, Said & Friesen (2019), where the male teachers outperformed their female counterparts in scientific subjects involving laboratory components. Rahimi & Asadollahi (2012) undertook a related study which showed that male and female teachers were different in their styles of teaching, this supporting the findings of this research. Marban & Mulenga (2019) agreed that gender influences teachers' method of teaching. However, our results here disagree with the findings of Anbuthasan & Balakrishnan (2013), and that of Anderson (2011) as cited in Tweed (2013). This disparity suggests varying outcomes on the influence of teacher gender on the utilization of teaching methods.

Fig. 5 revealed that the years of teaching experience of the Mathematics teachers affects the choice of teaching methods by 2.22%. This is a very small margin which can be summarily neglected so that the teachers' years of teaching experience can be said to be inconsequential to the teaching methods used by the teachers. Rahimi & Asadollahi (2012) did not find any correlation between teachers' experience, age and choice of teaching methods. This result contradicts the findings of Pressley & Rangel (2023), and Wolters & Daugherty (2007) as discussed in Rahimi & Asadollahi (2012) which

inferred a more significant correlation. Finally, the study showed that the more educational qualification a teacher possesses, the more teaching methods the teacher utilizes in teaching Mathematics. This can be seen as illustrated in Fig.7. This finding corroborates that of Rotumoi & Too (2012), and Ng, Nicholas, & Williams (2010), Wetheim & Leyser, (2002) in Hartlep & McCubbins (2013). This positive correlation demonstrates that teachers who have higher educational qualifications display better understanding of pedagogical approaches and this is reflected in their increased range of adopted teaching methods. Contrarily, Tribble (2020) is of a divergent view, as their work did not equate higher qualification to better classroom competence.

Putting it all together, there is a notable interplay between various factors that affect the adoption of certain teaching methods for Mathematics by secondary school teachers in Owerri Municipal council of Imo State. While teachers' experience, qualification and gender are influential to the choice of teaching methods to varying degrees, it is obvious that the results still vary across different studies and locations. It is therefore very important to consider several factors in the design of teaching methods, thus ensuring the academic achievement and growth of the learners.

5.0 CONCLUSION

The teaching of Mathematics is an issue of great concern to stakeholders in education. This study obtained some empirical evidence on the factors affecting teaching methods utilized by secondary school Mathematics teachers in teaching Mathematics in Owerri Municipal Council of Imo State. From the findings, it was concluded that apart from the laboratory method, all the other eight methods being tested are utilized by secondary school Mathematics teachers in teaching Mathematics in Owerri Municipal council of Imo state. The study also showed that the gender of the Mathematics teachers affects the teaching methods used by the Secondary School Mathematics Teachers by 11.11% with the male gender showing higher competence, the years of teaching experience of the Mathematics teachers contributes to the choice of teaching methods by 2.22% with self-efficacy improving with more years of teaching,

and the educational qualification of a teacher influences the teaching methods used by 33.33%. This makes the teachers' educational qualification the most significant factor among the three factors investigated.

Based on the research findings and owing to the importance of Mathematics, it is recommended that it is appropriate and very important that educators thoroughly acquaint themselves with the various teaching methods available for teaching Mathematics in secondary schools. Teachers should be enriched with a treasury of varied mathematical resources which they can access freely as well as contribute to. Networking of school teachers among themselves as well as with university teachers will help to foster collaboration and sharing of knowledge. Government and Non-Governmental Organisations can organize television and radio shows that promote a love and passion for Mathematics. Since the youths are fascinated by music, videos and internet social networks, Mathematics programmes should be incorporated into some of such to create positive impact and ignite zeal from an early age. Mathematics clubs, like book clubs, could be formed to enhance Mathematics teaching by activities/games method. Teachers should also be appropriately and adequately motivated as this can enhance their performance of their duties, as results of the study imply that all secondary school mathematics teachers do not fully utilize all the teaching methods available to teach mathematics.

Due to lack of time and financial constraints, the study was limited to Owerri Municipal Council Area. Extending this research to a larger geographical area will definitely return more comprehensive insights. Outside of the variables considered here, other variables like the learning style of the learner and lack of motivation for Mathematics teachers, to mention a few, could be further researched on, to find out the extent to which they may or may not impact on the use of some of these teaching methods by Mathematics teachers.

In conclusion, this research work emphasizes the significance of the effective and efficient teaching and learning of Mathematics in secondary schools, especially considering some factors that influence the teaching method adopted by the teachers. Whilst acknowledging that continuous research is necessary for

improved teaching of mathematics, some practical suggestions and recommendations have been proffered. It is hoped that these

inspires an increased appreciation for the subject of Mathematics.

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EFFECT OF INTERACTIVE WHITE-BOARD ON ACADEMIC ACHIEVEMENT AMONGST PRIVATE SENIOR SECONDARY SCHOOLS IN NASARAWA LOCAL GOVT AREA, KANO STATE, NIGERIA.

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Abstract

The study investigated the effect of using interactive whiteboard on academic achievement amongst private senior secondary schools in Nasarawa local govt area of kano state, Nigeria. Three research items were raised in objectives, research questions and hypotheses respectively. A random sampling method was used in selecting 170 students from a population of 1054 students. The experimental group was taught using an Interactive Whiteboard (IWB), while the control group was taught using the conventional teaching method. The study utilized two groups, the experimental group and control group. The instrument used for the study was the Mathematics Achievement Test (MAT) which were administered at the beginning and at the end of the study to investigate the success of both groups. The results were evaluated by using the software SPSS. Findings and results disclosed that the experimental group outperformed the control group with respect to their achievements. The IWB appeared to have significant effects on the achievements of students for learning mathematics at senior secondary schools. Recommendations were made on how to improve teaching and learning mathematics using Interactive whiteboard.

Keywords: Interactive Whiteboard, Mathematics Achievement, Mathematics Teaching, Random Sampling.

Introduction

The role of mathematics in our present day society can never be over emphasized. Mathematics is generally believed to be a fundamental subject because of its arithmetic and logical reasoning which are the basis of science and technology. To many individuals, it is regarded as the bedrock of all subjects that triggers new innovations in the field of science. There is no doubt that every society is dependent on the knowledge of mathematics for its socio-economic development. Studies suggest that mathematics as a subject affects all aspects of human life at different levels.

Over the past two decades, researchers have made a significant breakthrough in determining the factors that influenced students' achievements particularly in mathematics (Reardon et al., 2009). Major investigations reveal the use of technology in the classroom. The researchers are of the opinion that for students to be able to heightened their achievement in mathematics, classroom technology must come to play.

Mathematics Achievement is of course the competency shown by students in the subject mathematics which is measured by the scores obtained through the achievement test. However, quite a number of researchers are in support of enhancing students achievement in mathematics through the use of technology. In a balanced mathematics program, the strategic use of technology strengthens mathematics teaching and learning (Dick & Hollebrands, 2011).

In the present day's technology standards (ISTE, 2000) challenge teacher education programs across the nation to address the need to produce computer literate teachers who are not just knowledgeable of the internet, word processing programs, spreadsheets, and presentation software, but are also confident in their ability to incorporate instructional software and websites into everyday classroom teaching. The interactive whiteboard proved to be an exciting and fun bit of technology to integrate. It affects learning in several ways, including raising the level of student engagement in a classroom, motivating students and promoting enthusiasm for learning (Bacon, 2011). Interactive

whiteboards support many different learning styles and are used in a variety of learning environments (Chapell, 2003). Research shows that designing lessons around interactive whiteboards helps educators streamline their preparation, be more efficient in their Information and Communication Technology (ICT) integration and increase their productivity overall. Research also indicates that notes taken on an interactive whiteboard can play a key role in the student review process, leading to higher levels of student attendance (Solvie 2001, Kent 2003, Allen 2010 and Bacon 2011). Gerard and Widener (1999) find that “the Interactive whiteboard supports interaction and conversation in the classroom; it helps with the presentation of new cultural and linguistic elements cited in Al-Saleem (2017).

There is no doubt that enormous responsibility lies in the hands of the school and teachers in ensuring that students are properly reached out to in terms of knowledge acquisition. Acquiring the desired knowledge in this modern age requires application of technology in the classroom. More and more ICT gadgets and devices are in constant increase in the field of education. Modern devices replace the traditional ones such as desk, chalkboard etc by interactive whiteboard (IWB).

An Interactive White Board is a touch-sensitive screen that works in conjunction with a computer and a projector. It is a presentation device that interfaces with a computer. The computer images are displayed on the board by a digital projector, where they can be seen and manipulated. Users can control software both from the computer and from the board. Participants can add notations, and emphasize by using a pen and or highlighter tool. By using his/her finger as a mouse, the teacher or student can run applications directly from the board. Another user at the computer can also have input. Any notes or drawings can then be saved or printed out and distributed to group members. According to Bell (2002): The interactive whiteboard is an excellent tool for the constructivist educator. Twiner (2010) affirmed that IWBs, would provide the sort of innovative technology that would support 'better' learning in a whole-class setting. This dominant discourse claimed that IWBs would 'transform'

and 'revolutionize' teaching and learning. In the traditional teachers' role, where the teacher was in the centre of a lesson, changes. The teacher becomes a helper while the student gets a more active role. Therefore we should put more emphasis on theories on constructive pedagogy. The above ideas can be well adopted in a lesson held in an interactive environment. Furthermore the pedagogy of action also comes to the front, since the new devices offer new possibilities for this learning approach. Inductive learning can be enhanced by home assignments, tests and projects since most of the students have got a computer and internet connection (it is supported below survey). By assigning tasks to be made with the use of a computer at home, we can improve students' creativity as well. Thomas, Cutrim and Schmid (2010) noted that: The integration of interactive whiteboards in classrooms around the world over the last decade provides a fascinating case study of the current state of pedagogy and increasingly interventionist role adopted by governments in directing education policies and national curricula.

The integration of IWBs in classrooms also provides an interesting case study of technological determinism, in which the technology itself is seen as somehow inherently capable of ensuring effective pedagogy and enhanced student attainment. As it use to be with much education technology in the past, Selwyn (2011), IWBs were initially touted as the harbingers of a new dawn of learning. However, in the words of Laurillard (2008), 'education is on the brink of being transformed through learning technologies; however, it has been on the brink for some decades now'. To determine to what extent IWBs have lived up to their vaunted potential. The mere introduction of the technology does not guarantee an enhanced learning environment. The presence of IWBs can represent opportunities for teachers to use information in more effective ways, primarily in terms of organization and management, cited in Hockey (2013).

The capabilities of IWBs enhance the quality of interaction, and consequently, to improve conceptual mathematical understanding are broadly recognized in recent years. Interactive whiteboard (IWB) have moved from being

consisted a novelty into a regular part of the equipment of many classrooms, it provides interesting opportunities for students and teachers alike to interact with digital content in multipersons learning environment from technological point of view. IWBs connect a computer linked to a data projector and a larger touch sensitive board that displays the image projected from the computer and allows direct input and manipulation

through the use of finger and styli, software provided with board offers additional functions at the touch of the screen.

As a result of its woman features, IWBS are claimed to have the potential to enhance demonstration and modelling to improve the quality of alterations and promotion of effective questioning ; to redress the balance of making resources and planning for teaching to increase the race and depth of learning. IBW has the potential to transform mathematics teaching and in many cases it has clearly done so. Interactive whiteboards provide many opportunities for both teachers and the learners. Many studies have proved the impact and increase in motivation of learners as well as the teachers working with IWBs on lessons regularly. Levy (2002) describes IWBs as tools that provide teachers with the means to integrate multimedia resources (e.g. texts, images, videos, diagrams, figures, etc.) into their classes.

Getting correct and immediate feedback is essential for learners because they want to measure their progress and obtain answers in a short time. Teachers sometimes face difficulty in finding proper authentic materials for listening and speaking activities (Celce-Murcia, 2001). Jurdak (2004) states that technology enables teachers to make use of simulations to better elaborate certain mathematical concepts. The ability of the teacher to explain mathematical concepts is facilitated by technology. BECTA (2004) confirms that this technology contributes to the effectiveness of teaching by offering ways through which the teacher can model abstract ideas and concepts. But thanks to the immediate access to the internet with a number of different resources, this obstacle seems to have become obsolete. Various tools and working environment of IWBs are designed so that

teachers may save their materials in a kind of “projects” and re-use them as many times as they need it. Thus, instead of preparing new materials over and over, they can use and revise the already prepared materials, or even add something new, which is always done based on the students' feedback.

Gerard et al., (1999) argues that IWBs increase the conversation in the classroom since the teacher interacts with the students. Thanks to the fact that an IWB can display various types of language input (images, audio, video, etc.), and that it directly involves active participation of either of the teacher or of the students (they are asked to come to the board and work with it), it supports the notion of multiple learning styles such as visual, auditory, and kinaesthetic. Straková (2013) summarizes benefits of the use of modern technologies in a classroom and offers her list of advantages of using ICT in teaching languages. She mentions the following points: high motivation of learners, support of self-directed learning, support of self-management, access to internet sources, access to enumerable mobile applications etc.

It is rather most unfortunate that teacher have refused to avail themselves with the skills of using medium technology in the classroom they have remain glued to the traditional method of teaching, hence the cause of poor achievement on the part of the students. It is therefore believed that with the introduction of technology in the classroom, the achievement of students in mathematics will be greatly enhanced.

The main objective of this paper therefore, is to examine the effect of interactive whiteboard (IWB) on academic achievement amongst private senior secondary schools in Nasarawa Local Government area of Kano State, Nigeria.

Objectives of Study

The specific objective of the study therefore, is to;

1. Investigate if there is any significant difference in the mean scores of the experimental and control group before intervention.
2. Investigate if there is any significant difference in the mean scores of the

experimental and control group after intervention.

- Investigate if there is any significant difference in the achievement scores of the male and female students within the experimental group.

Research Questions

The study was aimed at answering the following research questions;

- To what extent does the academic achievement of the experimental group and the control group differ before applying the treatment (intervention).
- Was there any difference in academic achievement of the students after treatment (intervention)
- How does the academic achievement of the gender within the experimental group vary after treatment (intervention).

Null Hypotheses

The following hypothesis started in null form were tested at $p= 0.05$ to determine the relationship between the variable in the study;

H_{0_1} : There is no significant difference in the mean achievement of the experimental and control group before intervention

H_{0_2} : There is no significant difference in the mean achievement of the experimental and control group after intervention.

H_{0_3} : There is no significant difference in the mean achievement of the male and female students within the experimental group after intervention.

Significance of the Study

The study is expected to motivate and enhance the achievement of students in mathematics such that it will increase the interest of students as well as to appreciate the knowledge of mathematics better since it involves the use of technology. It will also enable prompt coverage of the academic syllabus since the electronic gadgets are made to provide instant solution as well as storing and retrieving of information. Better organisation and classroom management is also achieved during lessons as most students are exposed to mean ideas of acquiring knowledge through technology.

RESEARCH METHODOLOGY

Research Design.

The study adopted pre-test and post-test control group quasi experimental research design. The design had the experimental group (EG) and a control group (CG). The EG was exposed to the treatment using the interactive white board (IWB) while the CG was treated using the traditional teaching method.

Population of the Study

The population consists of all the privately owned senior secondary school students in Nassarawa Local Government area of Kano State, Nigeria.

Sample and Sampling Techniques

A total 80 students were randomly selected out of a population of 126 students from two randomly selected senior secondary school to form the samples for the study.

A random sampling technique was used at the level selecting the school as well as in selecting the samples for the two intact classes of experimental and control group.

Research Instrument

The research instrument used was a researcher made Mathematics Achievement Test (MAT). The instrument has two main parts. Part one contains basic information such as name of the school, age's groups, gender etc while part two contains thirty (30) objective items with each having four options A–D.

Instrumentation

As a necessary requirement, permission was sought from the Principal of the schools to be used for the study. One mathematics teacher was selected from each of the schools to serve as research assistant. They were trained for one working week (5 days) by the researcher, and were also given detailed plan and instruction on the study prior to the treatment.

A pretest was administered to the students in the experimental and control groups before embarking on the treatment. The pretest was administered in order to ensure that they have equal ability before embarking on the treatment. The second phase was the treatment exercise which lasted for two working weeks (10 days). The experimental group was taught using the Interactive Whiteboard (IWB). The treatment

lasted for 40 minutes. Also, the questionnaires were administered to the experimental group only at the end of the treatment. The Interactive whiteboard is an interactive electronic white board which can be used for different purposes. It is connected to a computer which displays the image seen on the computer screen. First the software (and hardware) must be engaged, and then the board must be oriented. Once the computer screen has been projected onto the Interactive Whiteboard, the user can control all Windows' applications with the touch of a finger. The user's finger becomes, in effect, the mouse. The user needs only to press the board's surface to open and close files, explore web sites on the internet, or operate software. A projection onto an Interactive Whiteboard is very different from a classic projection found on a computer screen. With an Interactive whiteboard the user is able to navigate from the board.

PRESENTATION-

The researcher activated the interactive whiteboard which was connected to a laptop so as to enable him explain and demonstrate the construction process using the navigation tools, commands and features while the participants

pay attention. Notes were taken in between. After repeated constructions, demonstration and solution to some exercises, the participants were allowed to redo some of the exercises with little guidance by the researcher and the regular mathematics teacher whom have already received training on the use of interactive whiteboard.

The researcher again demonstrated step-by-step construction work and some exercises while the participants were encouraged to work along with him. Thus every participants' was able to keep up with the pace of the researcher, although questions were posed in between the lesson. Finally, the researcher introduced some new task and encouraged the participants to find their own solutions. Again the researcher and the regular mathematics teacher were available to answer questions and help with technical problems. At the end, possible solutions were presented and discussed generally to wind up the tutorial.

The control group was taught using the conventional teaching method and also lasted for the same duration of time as the experimental group. At the end of the treatment, a post test was administered to both groups and results analyzed using the t – test statistical tool.

Table 1: Phases of Instrumentation

Phases	Parameters	EG	CG
1	Pre- Achievement Test	+	+
2	Lesson with IWB	+	-
3	Lesson without IWB	-	+
4	Post Achievement Test	+	+

Table 1 above represents the steps adopted in the data collection procedure where positive (+) indicates utilization of instrument while negative (-) indicates no instrument was utilized. EG stands for Experimental Group while CG- Control Group.

Validity and Reliability were obtained through constructive observation and through a test-retest measurement of the instrument, respectively. Test reliability measures of both instruments gave reliability coefficient of 0.728 and 0.682 for the achievement test respectively.

Data Analysis

The collected data of the achievement tests (pre-test and post-test) was tabulated, analysed and interpreted. The data was analysed by mean score frequencies and t- test analysis as well as using computer software MS-Excel and SPSS.

Hypotheses Testing

H₀: there is no significant difference in the mean achievement scores between the experimental group and the control group before the treatment.

Table 2: Pretest Achievement for EG and CG

Group	N	Mean	SD	df	t-cal	t-crit	Dec.
Experimental	40	62.61	2.19	78	0.208	1.980	Retained
Control	40	62.36	2.42				

From table 2, it is observed that t-critical has a value of **1.980** while the t-calculated has a value of **0.208** indicating that the t-crit. is greater than the t-cal. Thus, the decision is retained. Meaning that both groups have same level of achievement and therefore, the researcher can continue with

the treatment.

H₀: there is no significant difference in the mean achievement scores between the experimental group and the control group after the intervention.

Table 3: Posttest Achievement for EG and CG

Group	N	Mean	SD	df	t-cal	t-crit	Dec.
Experimental	40	80.96	5.83	78	2.477	1.980	Rejected
Control	40	68.97	3.57				

From table 3, The t-calculated obtained is **2.477** while the t-critical is **1.980** indicating that the t-cal is greater than the t-crit at **0.05** level of

significance. Hence, the decision is rejected. Meaning that, the experimental group has higher level of achievement than the control group.

Table 4.8: Summary of the t -test Analysis of Male and Female Experimental Group at Posttest

Group	N	X	SD	Df	t-cal.	t-crit.	Dec.
Expt.(Male)	42	75.96	11.54	77	0.72	1.98	Not Sig.
Expt.(female)	37	74.92	12.77				

Statistical evidence on this null hypothesis showed that there was no significant difference between male and female achievement at the posttest because the t-calculated value was found to be 0.72 while the t-critical value obtained was 1.98 at P 0.05 level of significance. Hence the hypothesis was retained, indicating that there was no significant difference in performance of the male and female students' performance after exposing them to IWB demonstration method.

Discussion

The findings from the first hypothesis revealed that the both the experimental and control group have the same ability which enabled the treatment to be administered on both groups. Findings from the second hypothesis revealed that the academic achievement of the experimental group is significantly higher than the control group which is consistent with the study by Hannafin and Foshay (2008), Ahmad, Fauzi et. al. (2010) and Ahmad Tarnizi et. al.

(2010). They found positive impact in utilizing mathematical learning devices, thus enhancing students learning and understanding.

Further research also indicates that notes taken on an interactive whiteboard can play a key role in the student review process, leading to higher levels of student attendance (Solvie 2001, Kent2003, Allen2010 and Bacon 2011). Gerard and Widener (1999) find that “the Interactive Whiteboard supports interaction and conversation in the classroom; it helps with the presentation of new cultural and linguistic elements.” Solvie (2001) investigated the correlation between the use of an Interactive Whiteboard as a delivery tool for literacy instruction in a first-grade classroom and student attention to and participation in the literacy lessons. Her research found: The Interactive Whiteboard was novel and created enthusiasm for learning on the part of the students as evidenced in remarks made during the lessons presented using the Interactive Whiteboard and during individual student interviews. It clearly demonstrates the instructional effectiveness of IWB as compared to the traditional construction tools. The findings revealed a significant difference on the performance of students when taught linear and quadratic equations using the IWB software. The experimental group appears to be more effective when compared with the control group.

Hohenwarter and Fucks (2004), on their research on function between the experimental and control group, the result of their findings showed that the use of IWB in the teaching and learning process contributes to the enhancement of students' conceptual and procedural knowledge in the function. Their findings also revealed that male and female students have similar ability when taught using IWB. However, findings from this study revealed slight difference in the performance of male and female students.

The third hypothesis which is on comparison

between the male and female academic achievement revealed that, the male students slightly performed better than the female students, which is in line with the findings of Azlin and Suhaila (2008), that the use of technology in mathematics was more effective for male students. Although both the experimental and control groups gained from the study. The research established that the experimental group gained more. It also reveals that IWB leads to better performance in mathematics examinations.

Latham's (2002) teacher-focused research finds “two-thirds of the teachers felt that the Interactive Whiteboard offered strategies for teachers to develop interactive teaching. One-third stated that pupils from all ability groups were now more willing to take part in lessons.” (Kent,2003) indicated that teaching with Interactive Whiteboards is “more fun, more engaging, more exciting and is impacting on the enjoyment, speed and depth of learning” (Lee and Boyle, 2003).

Conclusion

This study brings to light, the effectiveness of using IWB for teaching and learning of mathematics in our classroom. Finding from this study reveals that the use of IWB impacts positively on the performance of both male and female students. The use of IWB can therefore be extended to other related science subjects teaching. The study concludes that IWB is one sure way of eradicating poor performance of students in mathematics. Also, when it comes to gender equity, the study also concludes that technology benefited both girls and boys in learning mathematics even though boys performed slightly better than girls.

Recommendations

(i). There should be continuity in servicing mathematics teachers with regular information regarding the use of technology in the

classroom.

(ii). Studies should focus more on specific areas or topics of mathematics that students perform poorly rather than looking at mathematics from a general perspective.

(iii). Government should further direct and support the use of IWB for learning mathematics. This will make mathematics more exciting and interesting for the learners.

(v). In areas of mathematics where girls are challenged, the IWB is likely to improve attitude and hence improve their performance in mathematics. Teachers should therefore use appropriate technology in teaching girls.

(vi). Organizing workshops and seminars on the use of IWB should be given a priority by the authority.

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EFFECTS OF JIGSAW COOPERATIVE LEARNING STRATEGY AND LECTURE INSTRUCTIONAL APPROACH ON STUDENTS' MATHEMATICS ACHIEVEMENT IN SCHOOLS IN DELTA STATE

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Abstract

Mathematics is a core subject from the primary to the secondary level of Nigerian educational system. The level of achievement in the Senior Secondary School Certificate Examination (SSCE) has remained unimpressive, hence this study examined effects of jigsaw cooperative learning strategy and lecture instructional approach of student mathematics achievement in schools in delta state. The sample of the study consist of two hundred and forty students(240), (135 males and 105 females) in SSII randomly selected from a population of 39, 904 students using simple random sampling. Three research questions and three hypotheses were raised and formulated for this study. Two schools were randomly selected for the experimental groups (Jigsaw group), Two schools for lecture group and one school for the revision group(control). Geometry Achievement Test (GAT) item was used for both pretest and post test as instrument for data collection. The reliability of the instrument was established using Kuder Richardson 21 (KR-21) and the reliability of 0.83 was achieved, the data collected were analyzed using mean and standard deviation to answer the research question and ANCOVA and t-test to test the hypotheses at 0.05 level of significance. The findings reveal that there is a significance difference of student achievement in Mathematics in favour of the jigsaw learning strategy group, no significance difference was found on male and female student taught using jigsaw cooperative learning strategy. The study recommends that jigsaw cooperative learning strategy should be adopted for teaching of geometry concepts in senior secondary schools.

Keywords: Jigsaw Cooperative Learning Achievement, Geometry

Introduction

Mathematics is a branch of science which deals with numbers and their operations; it involves calculations and problem solving. Odogwu (2014) defined mathematics as a science of numbers which systematically digs out patterns, rules, principles and theories to explain events. Mathematics is important to human and national development hence Kravitz (2013) observed that mathematics is one skill everyone needs to learn, according to him so that one will be able to live without being cheated. Because of the importance mathematics, it has been included in the National Policy on Education FRN (2004). Mathematics is a core subject from the primary to the secondary level of our educational system

and also a pre-requisite for admission into Nigerian universities. The National policy on education (FRN, 2013) had advocated for improvement in teaching and learning science related subjects especially mathematics as well as other sciences.

Inspite, of the place of mathematics as a core subject and its importance in human and technological development of a nation, the achievement of students in external examinations remain unimpressive from year to year. West African Senior School Certificate Examination (WASSCE) results for general mathematics a core subject showed that less than 50% of students passed at credit level and above, as in table below.

TOTAL NUMBER OF STUDENTS IN NIGERIA THAT SAT FOR THE MAY/JUNE WASSCE IN GENERAL MATHEMATICS BETWEEN 2010 – 2018

YEAR	TOTAL NO OF CANDIDATES	CREDIT (A1-C6) %	D7 – F9 %
2010	1,351,557	33.55	66.45
2011	1,540,250	38.93	61.07
2012	1,675,224	49.00	51.00
2013	1,543,683	36.00	64.00
2014	1,692,435	31.30	68.70
2015	1,593,442	38.68	61.32
2016	1,544,234	27.31	72.69
2017	1,560,000	48.15	52.75
2018	1,570,000	33.81	66.29

SOURCE: Test development division, West African Examination Council (WAEC) Lagos.

The general concern of every stakeholder on mathematics is to improve the achievement of students and to look into possible reasons for the poor achievement in mathematics. The chief examiners report May/June (2007 – 2012) indicated that the poor achievement is a result of poor attempt in geometry questions. Hence researchers have continued to search for different methods of teaching. Tali and Dogo (2019) investigated the effect of collaborative learning approach on upper basic two students' interest in mathematics, the findings of the study indicated that collaborative learning approach significantly improve students' interest over conventional learning strategy. Chika et al (2019) examined the effects of cooperative learning strategy on academic achievement of secondary school students in algebra and quadratic equations. Their findings from the study showed that students taught with cooperative learning strategy achieved higher than those exposed to the traditional lecture approach, also female exposed to cooperative learning strategy achieved slightly higher their male counterparts but the difference was not statistically significant.

Geometry is a field of study in mathematics which helps students to associate geometric patterns; it enables students to apply geometrical concepts on problem-solving. Learning

geometry tends to improve basic skills of students in analyzing, comparing and generalizing (Baltisa, 1999, Idris 2006). Geometry equips students with scientific thinking skills like examining, researching, being critical schematizing thoughts and expressing thought clearly. The chief examiner's report (2009 – 2014) also identified circle geometry as students area of weakness and that students fail to attempt question or that questions are poorly answered. Geometry has been identified as an abstract complex concept in mathematics. It is taught from primary to secondary school levels in Nigerian schools to enable the students understand natural phenomena and develop power of critical thinking and reasoning. Unfortunately, students perform poorly in questions involving geometry thereby creating the persistent poor achievement in mathematics. Chief examiners report for WAEC (2007 – 2010) (Ale & Adetula 2010, Lassa, 2012). The poor achievement in mathematics however seem to affect female students more than their male counterparts as research evidence has shown that males perform better in major branches of mathematics like geometry, algebra and trigonometry (Bot, 2012). The traditional lecture method is a teacher-centered teaching approach which is the most common instructional approach in the world, the

traditional lecture is a 40 – 50 minutes of uninterrupted discourse from a teacher to the students, during this period students are typically limited to listening, copying from the board without much student interaction except when permitted to ask questions, this Ajaja (2009) observed as a major limitation as there is little student activity, also Ruhl (2003) opined that just giving out the rules/formulae without proper understanding may lead to rote learning hence poor achievement in examinations. But lecturing has some unique advantages which include: guide exposure to new materials, greater teacher control in the classroom, an engaging format which could clarify course material average of large content material within a short time in a large class.

The Jigsaw cooperative learning strategy is a cooperative learning strategy which organizes students in small groups such that they can work together to maximize their own and each other's learning (Trowbridge, 2000). The Jigsaw classroom cooperative technique was introduced by Elliot Aronson (1978). This study will therefore examine the Jigsaw cooperative learning strategy and the lecture instructional approach to find out which method best suits the teaching of mathematics in senior secondary schools in Nigeria.

In the Jigsaw classroom, the teacher presents a topic and its “sub”, while students are divided into small groups of four, five or six which is referred to as the jigsaw “home groups”. In each group a student's is assigned an individual sub topic which they are to study independently from the provided material, the students with the same “sub topic” come together as an “expert group”, there they teach themselves and come up with a common position on the assigned topic. In the Jigsaw class, an atmosphere of increased collaboration is created because every member of the group is equally important. Students are valued by other group members and need to participate actively to add to the group activity.

Empirical studies have shown that students centred learning like collaborative approaches have the ability to improve students' achievement in mathematics more than the lecture approach. There have been varied findings on the effect of cooperative learning strategies on male and female students' achievement. It is therefore necessary to carry out further studies to provide more empirical findings on the effects of jigsaw and particularly on the difference on the achievement on male and female students on geometry. This is the gap this study intends to fill.

Statement of the Problem

The traditional lecture approach still prevails in many schools till date because of its advantages, as it can be used by teachers to cover more content materials within a short time and can be used for large classrooms, greater teacher controls an engaging format which can help to clarify course material but some studies have revealed that this method leads to rote learning and students depend on the teacher and hence may be the reason for the unimpressive achievement in mathematics.

This study also examined an alternative strategy for teaching mathematics in the use of Jigsaw cooperative learning strategy which involves students' active participation in group learning where each member contributes to the success of the group. The problem of the study therefore will be the use of Jigsaw cooperative learning strategy and the lecture instructional learning approach have any significant differential effect on students' achievement in geometry in schools.

Research Questions

To guide the study, the following research questions were raised.

1. What is the difference in the mean geometry achievement scores of students taught with Jigsaw cooperative learning strategy, lecture instructional

- approach and revision group?
2. What is the effect of Jigsaw cooperative learning approach and lecture instructional approach on students' achievement in geometry?
 3. What is the difference between the mean achievement score of male and female students taught geometry with Jigsaw cooperative learning approach?

Hypotheses

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

- HO₁: There is no significant difference in the mean achievement scores among students taught geometry with Jigsaw cooperative learning strategy, lecture instructional approach and revision group.
- HO₂: There is no significant effect of Jigsaw cooperative learning approach and lecture instructional learning approach on students' achievement in geometry.
- HO₃: There is no significant difference in the mean achievement scores of male and female taught geometry with Jigsaw cooperative learning approach.

Procedure for Data Collection

The researcher trained two teachers as research assistant who facilitated the treatment on Jigsaw

Design Format

Group	Pre-test	Treatment	Post-test
Jigsaw cooperative group	O ₁	X ₁	O ₂
Lecture group	O ₃	X ₂	O ₄
Control group (Revision Class)	O ₅	----	O ₆

Where O₁, O₃, O₅ represent pre-test for Jigsaw Cooperative group and lecture groups respectively O₂, O₄, O₆ represents post-test for Jigsaw Cooperative learning group and lecture groups X₁ represent treatment for Jigsaw cooperative learning group and X₂ represent treatment for the lecture instructional group.

cooperative learning group and two teachers for the lecture group classes in the selected schools. The study lasted for six weeks, in the first week the students were informed about the objectives of the study and the geometry achievement (GAT) was administered on the three groups as pretest. From the second week, the jigsaw group were shared into groups and the six weeks instructional unit prepared by the researcher on geometry was used as treatment here the research assistant are facilitators but the lecture group were taught twice every week by their teachers using the same instructional material prepared by researcher for uniformity. The revision class were left to revise on their own geometry concept without any material given to them. At the end of the sixth week, post-test was administered to all the groups and data collected.

Methods

The study adopted a pre-test, a post test, control group, quasi experimental design. The population of the study consists of all the senior secondary school two (SSII) students in Delta state. There are four hundred and seventy-four (474) public secondary schools with a population of 39,904 (Thirty-nine Thousand nine hundred and four) students comprising of female and male students.

- O_1 = Pre-test jigsaw group
 O_3 = Pre-test lecture group
 O_5 = Pre-test revision group
 X_1 = Treatment for jigsaw group
 X_2 = Treatment for learning group
 = No treatment for revision group
 O_2 = Post-test for jigsaw group
 O_4 = Post-test for lecture group
 O_6 = Post-test for revision group (Control)

The sample of the study consisted of two hundred and forty (240) senior secondary two (SSII) students selected from five schools (five intact classes) in Delta state. Simple random sampling was used to select the five schools used for the study. The instrument of the study is geometry achievement test made up of 50 multiple choice questions. The instrument (GAT) was used to collect the pre-test scores and post-test scores after six weeks of treatment. The reliability of the study was done using the Kuder-Richardson (KR- 21) formula and a

reliability coefficient of 0.83 was achieved. Three research questions were answered using descriptive statistics (mean and standard deviation). Hypothesis 1 was tested for significance using Analysis of Covariance (ANCOVA) while hypotheses 2 and 3 were tested using t – test, hypotheses testing was done at 0.05 level of significance.

Results

Presentation of Results

The results of the analyzed data are presented in tables according to the research questions and corresponding hypotheses that guided the study. The results are interpreted immediately after the tables.

Research Question One: What is the difference in the mean geometry achievement scores among students taught geometry with jigsaw cooperative learning strategy, lecture learning approach and revision group?

Table 1

Mean (\bar{x}) and Standard Deviation (SD) of Pretest and Posttest Achievement Scores of Students Taught Geometry Using Jigsaw Cooperative Learning Approach, Lecture approach and Revision Group

Group	N	Pretest		Posttest		Mean Difference
		\bar{x}	SD	\bar{x}	SD	
Jigsaw	108	14.08	5.55	71.85	12.73	57.77
Lecture	89	14.75	5.69	65.57	13.62	50.82
Revision	43	14.53	5.60	46.35	13.40	31.82

Table 1 shows a pretest mean achievement score of 14.08, with a standard deviation of 5.55, for students taught geometry using jigsaw cooperative learning approach, a pretest mean achievement score of 14.75, with a standard deviation of 5.69, for students taught geometry using lecture approach and a pretest mean achievement score of 14.53, and standard deviation of 5.60, for students in the revision group. Students in the jigsaw cooperative learning group, had a posttest mean achievement score of 71.85, with a standard

deviation of 12.73, those in the lecture group had a posttest mean achievement score of 65.57, with a standard deviation of 13.62, while students in the revision group had a posttest mean achievement score of 46.35, with a standard deviation of 13.40. The mean difference (posttest-pretest) for jigsaw cooperative learning, lecture and revision groups are 57.77, 50.82 and 31.82, respectively. The variation in the mean difference of the three groups implies a difference in the mean achievement scores among students in the

groups. The corresponding hypothesis was tested to ascertain if these differences were significant.

Hypothesis One: There is no significant difference in the mean achievement scores

among students taught geometry with jigsaw cooperative learning strategy, lecture instructional

Table 2

Summary of AN COVA Comparison of Posttest Mean Achievement Scores of Students Taught Geometry Using Jigsaw Cooperative Learning Approach, Lecture Approach and Revision Group

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	20089.098 ^a	3	6696.366	38.392	.000
Intercept	110665.638	1	110665.638	634.474	.000
Pretest	31.775	1	31.775	.182	.670
Methods	20085.568	2	10042.784	57.578	.000
Error	41163.398	236	174.421		
Total	1073823.000	240			
Corrected Total	61252.496	239			

P<0.05

Table 2 shows that there is a significant difference in the posttest mean achievement scores among students taught geometry using jigsaw cooperative learning approach, lecture approach and revision group, $F(2, 236) = 57.578$, $P(0.000) < 0.05$. Hence, the null hypothesis is rejected. Therefore, there is a

significant difference in the mean achievement scores among students taught geometry using jigsaw cooperative learning approach, lecture approach and revision group. A post-hoc test as shown in Table 4 was used to determine the direction of the difference.

Table 3

Summary of Scheffe's Post -hoc Test Comparison of Jigsaw Cooperative Learning, Lecture and Revision Groups on Achievement

(I) Teaching methods	(J) Teaching methods	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Jigsaw	Lecture	6.323 [*]	1.893	.001	2.592	10.053
	Revision	25.532 [*]	2.382	.000	20.839	30.226
Lecture	Jigsaw	-6.323 [*]	1.893	.001	-10.053	-2.592
	Revision	19.210 [*]	2.453	.000	14.377	24.043
Revision	Jigsaw	-25.532 [*]	2.382	.000	-30.226	-20.839
	Lecture	-19.210 [*]	2.453	.000	-24.043	-14.377

Table 3 shows that there is no significant difference between the mean achievement scores of students taught geometry using jigsaw cooperative learning approach and those taught using lecture approach ($P(0.001) < 0.05$), in favour of jigsaw's students; there is a significant difference between the mean achievement

scores of students in jigsaw cooperative learning group and those in the revision group ($P(0.000) < 0.05$), in favour of students in jigsaw cooperative learning group; and there is a significant difference between the mean achievement scores of students in lecture group and those in the revision group ($P(0.000) <$

0.05), in favour of students in lecture group. As indicated in table 6, jigsaw cooperative learning, followed by lecture approach promotes students' achievement in geometry than the revision group.

Research Question Two: What is the effect of Jigsaw cooperative learning approach and lecture instructional approach on students' achievement in geometry?

Table 4
Mean (\bar{x}) and Standard Deviation (SD) of Pretest and Posttest Achievement Scores of Students Taught Geometry Using Jigsaw Cooperative Learning and Lecture Approaches

Group	N	Pretest		Posttest		Mean Gain
		\bar{x}	SD	\bar{x}	SD	
Jigsaw	108	14.08	5.55	71.85	12.73	57.77
Lecture	89	14.75	5.69	65.57	13.62	50.82

Table 4 shows a pretest mean achievement score of 14.08, with a standard deviation of 5.55, for students taught geometry using jigsaw cooperative learning approach and students taught geometry using lecture approach had a pretest mean achievement score of 14.75, with a standard deviation of 5.69. As for the posttest, students in the jigsaw cooperative learning group had a mean achievement score of 71.85, with a standard deviation of 12.73, while their counterparts in the lecture group had a mean

achievement score of 65.57, with a standard deviation of 13.62. The mean gains for jigsaw cooperative learning and lecture groups are 57.77 and 50.82, respectively. The mean gain showed that jigsaw cooperative learning and lecture approaches had effect on students' achievement in geometry.

Hypothesis Two: There is no significant effect of jigsaw cooperative learning approach and lecture instructional learning approach on students' achievement in geometry.

Table 5
Summary of Paired Samples t -test Comparison of Pretest and Posttest Mean (\bar{x}) Achievement Scores of Students Taught Geometry Using Jigsaw Cooperative Learning and Lecture Approaches

Group	N	Pretest		Posttest		Df	t-cal	sig. (2-tailed)	Remark
		\bar{x}	SD	\bar{x}	SD				
Jigsaw	108	14.08	5.55	71.85	12.73	107	44.273	0.00	Ho ₂ is rejected
Lecture	89	14.75	5.69	65.57	13.62	88	33.003	0.00	

P<0.05

Table 5 shows that there is a significant effect of jigsaw cooperative learning and lecture approaches on students' achievement in geometry ($t=44.273$ & 33.003 , $P(0.00$ & $0.00) < 0.05$). Hence, the null hypothesis is rejected. Therefore, there is a significant effect of jigsaw

cooperative learning and lecture approaches on students' academic achievement in geometry.

Research Question Three: What is the difference between the mean achievement score of male and female students taught geometry with Jigsaw cooperative learning approach?

Table 6
Mean (\bar{x}) and Standard Deviation (SD) Posttest Achievement Scores of Male and Female Students Taught Geometry Using Jigsaw Cooperative Learning Approach

Method	Sex	N	Posttest		Mean Difference
			\bar{x}	SD	
Jigsaw	Male	55	73.16	12.28	2.67
	Female	53	70.49	13.16	

Table 6 shows that male students in the jigsaw cooperative learning group had a posttest mean achievement score of 73.16, with a standard deviation of 12.28, while their female counterparts had a posttest mean achievement score of 70.49, with a standard deviation of

13.16. The mean difference between the two sex groups is 2.67, in favour of male students.

Hypothesis Three: There is no significant difference in the mean achievement scores of male and female taught geometry with jigsaw cooperative learning approach.

Table 7
Independent Samples t -test Comparison of Posttest Achievement Scores of Male and Female Students Taught Geometry Using Jigsaw Cooperative Learning Approach

Methods	Sex	N	\bar{x}	SD	df	t-cal.	Sig. (2-tailed)	Decision
Jigsaw	Male	55	73.16	12.28	106	1.092	0.277	Ho ₄ is not rejected
	Female	53	70.49	13.16				

P>0.05

Table 7 shows that there is no significant difference between the posttest mean achievement scores of male and female students taught geometry using jigsaw cooperative learning approach, $t\text{-cal} = 1.092$, $P(0.277) > 0.05$. Thus, null hypothesis four is not rejected. Therefore, there is no significant difference between the mean achievement scores of male and female students taught geometry with jigsaw cooperative learning approach.

Discussion

The findings of the study are discussed as following:

The study showed that there is a significant positive effect of jigsaw cooperative learning and lecture instructional approaches on students' academic achievement in geometry. This is predicated on the increased achievement scores after treatment using jigsaw cooperative learning and lecture instructional approaches. As indicated in Table 4, students taught geometry using jigsaw cooperative learning and lecture instructional approaches had a mean gain (difference between posttest and pretest mean achievement scores) of 57.77 and 50.82, respectively after treatment. This mean gain is as a result of treatment using jigsaw cooperative learning and lecture instructional approaches. Thus, the use of jigsaw cooperative learning and lecture instructional approaches positively influence students' achievement in geometry. This finding corroborates that of Saddiq, Salman and Adeniji (2017) who reported that jigsaw II cooperative learning strategy had significant effect on students' achievement in circle geometry. This finding also supports that of

Ajaja (2013) who reported that cooperative learning and lecture approaches had significant effect on students' achievement in biology.

Findings

The study revealed the following findings:

1. There was a significant difference in the mean achievement scores among students taught geometry using jigsaw cooperative learning approach, lecture approach and revision group, in favour of jigsaw cooperative learning approach, followed by lecture approach and revision group respectively.
2. There was a significant effect of jigsaw cooperative learning and lecture instructional approaches on students' academic achievement in geometry.
3. There was no significant difference in the mean achievement scores of male and female students taught geometry with jigsaw cooperative learning approach.

Conclusion

Based on the findings of the study, it was concluded that jigsaw cooperative learning and lecture instructional approaches have the ability to improve students' academic achievement of geometry, but jigsaw cooperative learning approach have greater ability to enhance students' academic achievement of geometry more than the lecture instructional approach. It was also concluded that the use of jigsaw cooperative learning and lecture instructional

approaches benefits students of both sexes equally. The study again concludes that, the effects of jigsaw cooperative learning and lecture approaches on achievement of geometry are not dependent on students' sex.

Recommendations

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

1. Jigsaw cooperative learning approach should be adopted by mathematics teachers in teaching mathematics (particularly geometry) at the senior secondary school level of education.

2. Mathematics teachers when using jigsaw cooperative learning approach should ensure that learning groups should be heterogeneous with respect to ability level, aptitude and sex among others.
3. Lecture instructional approach should be use as alternative instructional approach when the use of jigsaw cooperative learning is not feasible. However, mathematics teachers should ensure that students are active during instruction when the lecture instructional approach is employed.

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EFFECTS OF VISUAL-SPATIAL INSTRUCTIONAL STRATEGY ON ATTITUDES OF SECONDARY SCHOOL STUDENTS TO MATHEMATICS

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Abstract

*Mathematics in secondary school is important subject in Nigeria education and for gaining admission into higher institution in the country. However, the high rate of students' poor attitude toward mathematics education has been one of the major challenges affecting the academic performance of students in public secondary schools in Ondo State. Thus, this study investigated the attitudes of secondary school students to mathematics as a result of their involvement in visual-spatial instructional strategy. It also determined the influence of gender on the students' attitude to mathematics. Two hundred and ten secondary school (SSI) students of intact classes assigned to experimental and control groups in each Local Government Areas (LGAs) were the participants. The treatment lasted for 12 weeks. Three hypotheses were tested at 0.05 level of significance. A pretest, posttest control group, quasi experimental design was used. **Student Attitude Towards Mathematics Questionnaire** ($r = 0.73$) was used for data collection. Data were analysed using ANCOVA and **Scheffe post-hoc**. Findings showed that there was significant main effect of treatment on students' attitude to Mathematics ($F_{(2,308)} = 5.94$; partial $\eta^2 = 0.08$). Gender had no significant effect on students' attitude towards mathematics. It is recommended that Visual-Spatial strategy should be included in the curriculum to bring about effective teaching of mathematics and consequently, acquisition of positive attitude to mathematics.*

Keywords: Visual-spatial learning strategy, Attitude to mathematics and Gender

Introduction

Mathematics is a powerful tool for success in science and technology courses. The importance accorded Mathematics in the curriculum reflects the recognition of the vital role it plays in the contemporary society. In Nigeria, parents, policy-makers, and educationists are aware of the importance of Mathematics in the development of the economy. Scholars have also described Mathematics as the soul of science and technology (Okonkwo, Okafor-agbala and Obikezie, 2022). Also, McCallum, (2023) avers that Mathematics is at the center of the modern world. Cheng, Zhang, Wang, and Jiang, (2023) noted that in every branch of industry in the country, Mathematics has come to play an imperative role as a result of its widespread application in all areas of science, technology and the economy. Mathematics equips student uniquely to analyze and change the world (Heinzman, 2022). The poor performance of students in Nigerian senior secondary school Mathematics examinations nowadays is becoming alarming and therefore becomes imperative for whosoever have passion for education to be gingered towards improving the pathetic condition.

According to Wahyuddin, Nurdin and Pettalongi, (2022), attitude is the way someone thinks and feels about something, or the way one behaves towards something especially when it shows how one feels. There exists a strong relationship between students' attitudes and Mathematics achievement levels. Some studies have suggested that achievement levels have a causal influence on students' attitudes (Badmus & Jita, 2022). Several factors play a vital role in influencing student's attitude such as anxiety towards Mathematics, student's self-efficacy, self-concept, and extrinsic motivation (Tahar, Ismail, Zamani & Adnan, 2010). Several instructional strategies have been recommended for the teaching-learning process in Mathematics which include the use of personalized print-based instruction (Akinsola & Awofala, 2009), Self and cooperative instructional strategies, (Akinsola and Ifamuyiwa, 2008), Clubs and Games (Olasinde, 2022; Bećirović, 2023).

Visual-spatial learning strategy is one of eight types of learning strategy defined in Gardner's theory of multiple intelligences. It refers to a person's ability to perceive, analyze and understand visual information in the world

around them. Spatial understandings are necessary for interpreting, understanding, and appreciating our inherently geometric world. Children who develop a strong sense of spatial relationships and who master the concepts and language of geometry are better prepared to learn number and measurement ideas, as well as other advanced mathematical topics. Spatial ability has been recognized as one of the most important factors affecting the Mathematical performance of students (Christou, Jones, Mousoulides & Pittalis, 2006). Attitudes toward Mathematics are improved when students are instructed with concrete materials by teachers knowledgeable about their use. Visual-spatial learning strategy that will be used in this study to teach geometry in mathematics to see if it will enhance the attitude of students to mathematics. Gender according to Udousoro (2011) is defined as a cultural construct that distinguishes the roles, behavior, mental and emotional characteristics between female and male developed by a society. He also opines that the concept of gender does not support or suggest the dominance of male over female or vice versa in academics and other human resource development area but it stresses equality and equity in enhancing effective and efficient recognition, development and utilization of competencies and endowed capabilities of both sexes. It is this gender stereotypical attitude over the years, held by teachers and absorbed by students that play a major role in the future mathematical performance of females (Banaji, Greenwald and Nosek, 2002). It is also believed that Mathematics is for boys; this belief may further widen the gender gap in Mathematics achievement (Mutemeri and Mygweni, 2005). The result of this belief is that girls have much less ability than boys to go into Mathematics-related careers, including engineering and physical sciences. Several studies give evidence that compared to boys, girls lack confidence in doing mathematical sums and viewed Mathematics as a male domain (Meelissen and Luyten, 2008). The likely influence of gender factors on students' learning outcomes in mathematics was thus examined in this study.

The theoretical foundation upon which this study is built includes Howard Gardner Theory of Multiple Intelligence and Jean Piaget Theory of Constructivism (1980). These theories have a profound impact on instruction, as instruction is

now being turned from “teacher-centered” to “learner-centered”. Howard Gardner believed that people have multiple different ways of thinking and learning. He has since identified and described eight different kinds of intelligence, one of which is Visual-spatial intelligence.

Spatial Intelligence is an area in the [theory of multiple intelligences](#) that deals with spatial judgment and the ability to visualize with the mind's eye. It is defined by [Howard Gardner](#) as a human computational capacity that provides the ability or mental skill to solve spatial problems of [navigation](#), visualization of objects from different angles and [space](#), faces or scenes recognition or to notice fine details. Gardner further explains that Spatial Intelligence could be more effective to solve problems in areas related to realistic, thing-oriented, artistic and investigative occupations. Piaget's theory of constructivist learning has had wide ranging impact on [learning theories](#) and [teaching methods in education](#) and is an underlying theme of many [education reform](#) movements. Constructivism is often associated with pedagogic approaches that promote [active learning](#), or learning by doing, active learning must happen in order for knowledge to be owned by the learner.

Statement of the problem

The mass failure in Mathematics examinations is real and the trend of student's performance has been on the decline and this also has been traced to the use of conventional method of teaching and negative attitude towards the subject. Standards based Mathematics emphasizes the need to build a deep understanding of concepts. The use of Visual-spatial instructional method can help to take care of this problem. Therefore, this study examined the effect of Visual-spatial instructional strategy on students' attitude to mathematics in Ondo state, Nigeria.

Research Hypotheses

Ho1: Visual-spatial instructional strategy will have no significant main effect on students' attitude to mathematics.

Ho2: The gender of students will have no significant main effect on students' attitude to mathematics.

Ho3: There is no significant interaction effect of

Visual-spatial instructional strategy and gender on students' attitude to mathematics.

Method

The study adopted a pretest, posttest control group, quasi experimental design to determine the effect of Visual-spatial instructional strategy on students' attitude to mathematics in Ondo state, Nigeria.

Population and sample

Two Local government areas were randomly selected from Ondo state for this study. From these, six schools were purposively selected and intact classes were used. The researcher used 210 Senior Secondary School One (SS I) students of intact classes for this study. Schools were assigned as experimental and control groups using the purposive sampling technique. In all six schools were assigned with three serving as the experimental groups and three as control groups. The experimental and control groups comprised 110 and 100 participants respectively. The research assistants for the study were the mathematics teachers of the schools.

Student Attitude Towards Mathematics Questionnaire

Basically, the SATMQ is made up of two sections; section A and section B. Section A seek demographic information such as gender, school and class of the student. Section B consists of 25 items to find out the level of attitude of students towards Mathematics. Response mode of four-point scale of SA – Strongly Agree, A – Agree, D – Disagree, SD – Strongly Disagree will be used. This instrument developed by Fennema-Sherman was adopted and modified. The questionnaire was revalidated by trial testing it on a sample of 50 students from a school that will not be part of real study. The reliability coefficient of SATMQ using Cronbach Alpha was found to be 0.73.

Teaching guide for visual-spatial learning strategy

This teaching guide consists of 20 lessons that were used for teaching the experimental group.

It is a learner-centered instructional guide based on the use of visual-spatial materials for teaching the students. The teaching guide was given to three experience Mathematics teachers in a secondary school to rate and examine its content and face validity. Some of the guides were reconstructed based on the supervisor's recommendations.

Teaching guide for conventional teaching strategy

The instructional guide consists of 20 lessons that were used to teach SSI Mathematics student in the control group. The lesson was based on traditional ways of writing lesson note. The main features of the guide were general information, introduction, presentation and teaching, content, evaluation and conclusion. It is a teacher-centered approach because it focuses more on the teacher and activities in the classroom. The instructional guide was given to two experience Mathematics teachers for review. Their suggestions were incorporated into the final draft of the guides. Some of the guides were reconstructed based on the supervisor's recommendations.

Research Assistant Evaluation Sheet (RAES)

This was used to assess the level of mastery of instructional guide by the research assistant their eligibility for the main study. Validity and reliability of RAES were showed to the researcher's supervisor for his input. Inter-reliability was determined using Scott pie.

Procedure for data collection

Data were collected at the pre- test, and then the treatment was administered before the post test was used to collect the final data. This took a total of twelve weeks.

Testing of Hypotheses

Main effect of treatment on students' Attitude to Mathematics.

H₀₁: There will be no significant main effect of treatment on students' Attitude to Mathematics.

Table 1: ANCOVA table showing effects of Treatment and Gender on the Attitude of Students to mathematics.

Source	Sum of Squares	df	Mean Square	Df	Sig.	Partial Eta Square
Corrected Model	872.233	12	72.686	2.631	.003*	.177
Pre-Attitude	4.599	1	4.599	.166	.684	.001
Main Effects:						
Treatment Groups	327.939	2	163.970	5.935	.003*	.075
Gender	85.016	1	85.016	3.077	.081	.021
Treatment x Gender	63.133	2	4.876	1.143	.322	.015
Error	4061.511	308	27.629			
Total	4933.744	320				

(R-Squared =0.177, Adjusted R-Squared =0.110)

The results from table 1 shows that there was a significant difference between the Treatment group on Students' Attitude towards Mathematics ($F_{(2,308)} = 5.935, P < 0.05, \eta^2 = 0.075$). The effect size of 7.5% was moderate. Therefore, hypothesis 1 was rejected. To determine the magnitude of attitude, mean scores across the treatment groups, the estimated marginal means of the treatment groups are shown in table 2.

Table 2: Estimated marginal means of posttest of attitude by treatment

Treatment groups	Mean	Std. Error	95% Confidence Interval	
			Lower bound	Upper bound
Visual-spatial learning strategy	68.74	0.372	67.42	69.06
Conventional Strategy	64.13	0.403	63.85	64.40

Table 2 reveals that students exposed to Visual-spatial learning strategy had the adjusted post mean scores ($\bar{x} = 68.74$), followed by those exposed to conventional strategy with the mean score ($\bar{x} = 64.13$)

To determine the direction of the significant difference among the different groups, Scheffe Post hoc analysis was carried out and the results are shown in table 3.

Table 3: Scheffe Post hoc Test of Treatment by Attitude

	N	Mean \bar{x}	Visual-spatial learning strategy	Conventional Strategy
Visual-spatial learning strategy	110	68.74		*
Conventional Strategy	100	64.13	*	

* Pairs significantly different at $p < .05$.

Table 3 shows that Visual-spatial learning strategy was significantly different ($\bar{x} = 68.74$) from modified conventional strategy ($\bar{x} = 64.13$) groups. Therefore, the significant effect of treatment on attitude was due to significant differences obtained between Visual-spatial learning strategy and modified conventional strategy.

Main effect of gender

H₀2: There is no significant main effect of gender on students' attitude to Mathematics.

The results from table 1 shows that there was no significant main effect of Gender on Students' Attitude to Mathematics ($F_{(1,308)} = 3.077, P > 0.05, \eta^2 = 0.021$). Therefore, hypothesis 2 was not rejected.

H₀3: There is no significant interaction effect of treatment and gender on students' attitude towards Mathematics.

The result from table 1 shows that there was no significant interaction effect of Treatment and Gender on Students' Attitude towards Mathematics ($F_{(2,308)} = 1.143, P > 0.05, \eta^2 = 0.015$). Hence, the null hypothesis 3 was not rejected.

Discussions

The result obtained from the study revealed that the main effect of treatment on the students' attitude towards Mathematics was significant.

Visual-spatial learning strategy was significantly better than modified conventional strategy group. This was in agreement with the findings of Furinghetti and Pekkonen, (2002), Bye, Pushkar, and Conway (2007) that positive attitude towards Mathematics leads students towards success in Mathematics.

Visual-spatial learning strategy was better than modified conventional strategy group due to the facts that Visual-spatial perception provides student with information about our environment. According to Furinghetti and Pekkonen, (2002), the way a child perceives space and their position or orientation within that space can affect their gross motor skills and classroom performance. It is the ability to distinguish differences among similar objects or form. This skill helps children in understanding relationships and recognizing underlying concepts. This area is closely related to the problem solving and conceptual skills required for higher level science and math. When students are able to represent a problem or mathematical situation in a way that is

meaningful to them, it becomes more accessible. According to Fennell and Rowan, (2010), using representation whether drawings, mental images, concrete materials, or equations helps students organize their thinking and try various approaches that may lead to a clearer understanding and a solution. According to Badmus & Jita, (2022), attitude has a greater influence on aspects of learning which are emphasized in the classroom. Dulton (2004) concurs that attitudes are related to academic performance when measured on promotion grades. According to Fennell and Rowan, (2010), improving children's spatial skills may have positive impact on their future success in science technology and Mathematics.

Implications of findings

In view of the immense versatility of visual-spatial learning, the strategy should be incorporated into teacher educational programs in order to equip Mathematics students as well as Mathematics researchers with adequate instructional strategies that can make them effective students and teachers. Mathematics teachers should stop using the strategies that will not encourage students' active participation during instructional processes but only make them to be passive recipient of knowledge (auditory learners). Teachers of Mathematics should adopt the strategy so as to improve students' motivation and learning in a collaborative environment through meaningful activities.

Conclusion

The visual-spatial learning strategy was effective at improving students' attitude towards Mathematics because of the fact that it was student-centered. The study is in line with the work of Akinsola and Ifamuyiwa, (2008) and Akinsola and Awofala, (2009). The strategy also encouraged active participation of students to master the concepts; therefore, the students were able to solve problems in Mathematics. Due to the fact that the learners were involved in

different learning activities, they were able to identify misconceptions and make proper corrections. Furthermore, the strategy made teaching and learning flexible, promoted communication and cooperation towards effective learning among the students. Use of the strategy showed that students' attitude towards Mathematics irrespective of gender could be improved.

Recommendations

1. It is recommended that Mathematics teachers should make use of visual-spatial learning strategy as it is activity-based and student-centered, hence the quality and quantity of learning will be improved. The strategy should therefore be integrated into the school science curriculum.
2. There should be organization of seminars and workshops for Mathematics teachers where the various steps involved in visual-spatial strategy would be made known to them

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ICT RESOURCES BEYOND COVID-19 AND ITS PEDAGOGICAL IMPLICATION IN THE TEACHING AND LEARNING OF MATHEMATICS AMONG SECONDARY SCHOOL IN AKWA IBOM STATE, NIGERIA

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Abstract

The study investigated implementation strategies of ICT resources beyond Covid-19 and pedagogical implications in the teaching and learning of Mathematics among secondary school teachers in Uyo Education Zone, Akwa Ibom State Nigeria. The research design adopted was the descriptive survey comprised all Mathematics teachers in public secondary schools in Uyo education zone. The study adopted simple random and purposive sampling techniques in selecting the participating schools in selecting 179 SS3 students and 48 teachers from 49 schools that made up the zone. The instrument used for data collections was a questionnaire of 10 items titled availability and utilization of ICT questionnaire in Mathematics (AUICTQM). Data generated were analysed using descriptive mean test statistics. Results revealed that there is to a greatly extent adequate availability of ICT tools for teaching and learning of Mathematics, the study also reveals that teachers utilization of ICT resources effect the teaching of mathematics in secondary schools. Based on the results of the findings, it was recommended among others that there is a challenge of awareness on the part of teachers enormous benefit of ICT resources in helping teachers to organize and prepare adequately for classes. Students should be encourage to utilize ICT resources in learning Mathematics.

Keywords: ICT Resources, Pedagogy, Teaching, Learning, Covid-19, Mathematics

Introduction

Information and Communication Technology (ICT) is a key to education and knowledge. Its importance in business, health, academic and economy cannot be undervalued (Ofonime, 2023). In 2012 Nigeria concluded the new policy document on miss and vision of ICT policy in the country which includes: vision to make the country globally competitive and knowledge-based society; to integrate ICT into the socio-economic development of the country; and to transform Nigeria into a knowledge-based economy country since 2012 ICT has continued to relive on that note, special emphasis, and attention (FGN, 2012).

ICT is an extensional term for Information Technology (IT) that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals) and computers as well as necessary enterprise software, middleware, storage and audio-visual, that enable users to

access, store, transmit, understand and manipulate information (Wikipedia, 2022).

The term ICT is described as the information dissemination, storage and management of various sets of technical tools and resources that are accepted for information and communication technologies (Das, 2019). ICT has become one of the primary building's blocks of our modern society that can be used as a teaching strategy to overcome expenses, encompass teacher storage, reduces time and distance barriers along with low level of education.

Netsianda (2021) opines that the rapid growth of ICT has received considerable attention in education by Virtue of its capability to provide dynamic and innovative teaching and learning environment. He further reiterates that teachers are required to integrate ICT in their teaching with a view to supersede traditional method with modern tools and facilities.

ICT resources are instructional tools use for communication, instruction, and evaluation of

learning. It uses a blend of graphs, texts, sounds, and videos for learning process (Muller, 2014). Akpan and Inyang, (2013) expressed that laptops computers are learner-centered and activity oriented. The challenge is how to optimize usage. Anache, Olofin and Onah (2010) opined that computer-assisted instruction for instance the use of laptops can promote active learning in a wide variety of disciplines from literature to the social sciences and beyond. ICT resources platforms are useful to students and teachers and their usefulness cannot be overemphasized, as many institutions depends upon it especially during the Covid 19 era. Typical planning, preparation, and development time for a fully e-learning junior secondary school course is Six to Nine months before the course is delivered (Charles et al, 2020). This means that for educational institutions to effectively implement e-learning activities, they have to introduce the changes gradually (Orok & Esuong 2020).

The emergence of coronavirus which broke out first in Wuhan in the central part of China in 2019 circulated speeding, rapidly and globally almost all sectors of the world economy including education (Tran, 2021). Before the pandemic, Nigerian education system has adopted the conventional method of teaching other wisely known as face-to-face approach teaching and learning of subjects at both primary and post primary school.

Going by the drive of Covid-19 pandemic, lockdown orders were introduced across nations including Nigeria, these measures have brought negative effect on the educational institution across the countries (World Bank, 2020). These drastic changes caused by the pandemic, also triggered rapid changes in educational sector and thereby resulting in an upsurge in online teaching and learning which most educational institutions have prescribed to (Esuong & Edoho, 2018).). On that note educational institutions have responded to the lockdown

pandemic shift with different factors of strategies which include the use of you tube, goggle classroom, module, goggle meet, zone, canvass network learning management system and a whole of other on line facilities (Saavedra, 2020).

In the face of these identified problem, the research is undertaken to ascertain the level of implementation strategies of ICT resources in the Covid-19 and its effect on students' academic achievement in Mathematics.

Statement of the Problem

Mathematics is the fulcrum of all technological advancement. That is why, the federal government of Nigeria through the national policy on education maintained the compulsory nature of mathematics in all levels of education up to tertiary level though as a general course at the tertiary level (Esuong & Ofonime 2021). Government is making serious efforts to provide high quality mathematics education and one of such is the introduction of ICT resources in teaching and learning of Mathematics in secondary schools. But students interaction with digital technologies in education especially mathematics does not match their experiences at home or in their communities. For ICT to be effectively implemented, both teachers and students should be able to manipulate the computer system; have good knowledge of the available mathematics software packages they can use in their daily lesson, when to use synchronous and asynchronous online teaching and learning strategies and other aspects of ICT applications. Therefore it is a noticeable fact that ICT are not widely used in teaching and learning of mathematics in Nigeria secondary school system. As (Keshavarz, M., Rahimi, M. & Esmaili, Z. (2013) observed educators are continually reminded that, students in the past grew up in the dark intellectually and our role as teachers was to enlighten them. But in the 21st century, our students grow up in the light,

connected to the world by ICT long before they go to school. The gap between education and the rapid changing world outside seems to be widening, hence the need for this study to investigate the level of availability & implementation of ICT tools in teaching and learning mathematics beyond covid-19 among SS3 students in Uyo education zone of Akwa Ibom State Nigeria.

Purpose of the Study

The purpose of this study is to investigate the level of ICT resources pedagogical implication in the teaching and learning of mathematics and academic achievement of students in Uyo Education Zone, Akwa Ibom State.

The study sought to:

1. Find out the level of availability of ICT tools for the teaching and learning of mathematics in schools
2. Determine the extent of using ICT in teaching and learning of Mathematics by teachers beyond Covid-19
3. Determine the challenges of implementation of ICT tools in teaching Mathematics.

Research Questions

The study was guided by the following research questions

1. What is the level of availability of ICT tools in teaching mathematics in your school after Covid-19?
2. What extent do you used ICT tools in learning mathematics after Covid-19?
3. What are the challenges of implementation of ICT tools in teaching Mathematics?

Research Methods

The study adopted the descriptive survey design and it was carried out in Uyo Education Zone, Akwa Ibom State, Nigeria. The population of the study comprised all senior secondary three (SS3) students in public secondary schools in Uyo Education Zone of Akwa Ibom State numbered five thousand three hundred and fifty (5350) for 2022/2023 academic session, according to the State Education Board, Uyo (2023). The study adopted simple random and purposive sampling techniques in selecting participating schools in the zone and in selecting 179 SS3 students and 48 teachers from fifteen (15) schools in the zone out of forty-nine (49) schools that made up the zone.

The instrument used for data collection in this study was a questionnaire of 10 items titled availability and utilization of ICT questionnaire in Mathematics (AUICTQM).

The instrument was divided into three segments; section (A) collection of data in respects of availability of ICT resources filled by the students, section (B) for the extent of utilization of ICT resources and filled by the teachers. To measure the internal consistency of the instruments, the AUICTQM were administered to 20 samples of mathematics students from another education zone, who were not part of the study but found to be equivalent in all aspects to the sample o study. The result obtained in the administration were subjected to test-retest method and the internal consistency of 0.89 was obtained making the instrument reliable for the study.

Results

Respondents Profile:

Table 3 shows the respondents profile in the research

Description		Teachers		Students	
		N = 48		N = 179	
		N	%	N	%
Gender	Male	26	54	77	43
	Female	22	46	102	57
Qualification	Ph.D	-	0	-	-
	M.Sc	20	41	-	-
	B.Sc	19	40	-	-
	NCE	9	19	-	-

The table 3 above showed an explicit description of the number of female and male teachers and students among the forty-eight (48) teachers and one hundred and seventy-nine students. There are twenty-six (26) male teachers representing 54% of the entire sample and twenty-two (22) female teachers which also represented 46% of the entire teachers. There are equally seventy-seven (77) male students being 43% and one hundred and two (102) female students being 57% of the sample students.

The table further showed that out of the entire forty-eight (48) teachers who participated in the study, non-had obtained a Ph.D, twenty (20) possessed a masters of science (M.Sc.) degree, nineteen (19) had a Bachelor of Science (B.Sc) and only nine (9) had a Nigeria certificate in education (NCE).

Research Question 1: What is the level of availability of ICT tools in teaching mathematics in your school after Covid-19?

Table 2: Shows the teachers opinion on the level of availability of ICT tools for the teaching and learning of mathematics in schools after the Covid 19 in Uyo Education Zone

S/N	ITEMS STATEMENT	SDA	DA	NADA	A	SA	Total	\bar{x}	Decision	Pooled Mean
1	My school has a functional overhead projector for teaching and learning	15	23	28	48	65	179	3.7	Agree	
2	My school has a functional interactive whiteboard	15	23	11	60	70	179	3.8	Agree	
3	My school has a functional teacher and students computer	16	25	10	50	78	179	3.8	Agree	3.7
4	My school has a functional digital camara and camcorder	08	30	12	60	69	179	3.9	Agree	
5	My school has printers	25	35	20	49	50	179	3.4	Agree	

Analysis from Table 1 above showed **students opinion on the availability of ICT facilities in the teaching of mathematics in secondary schools** in Uyo Education Zone. From the data analysis in table above indicated that respondents Agree with items 1, 2, 3, 4 and 5 with mean 3.7, 3.8, 3.8, 3.9 and 3.4 respectively. There was no item disagreed in the decision from the mean. The pooled mean of 3.7 is greater

than the stated mean of 3.00. This implies that there is to a greater extent adequate availability of ICT tools for the teaching and learning of mathematics in most of the visited schools in the zone.

Research Question 2: To what extent does teachers' utilization of ICT facilities affect the teaching of Mathematics in secondary schools in Uyo Education Zone?

Table 3: Shows the teachers opinion on the extent teachers utilize ICT facilities in the teaching of Mathematics in secondary schools in Uyo Education Zone

S/N	ITEMS STATEMENT	SDA	DA	NADA	A	SA	Total	\bar{x}	Decision	Pooled Mean
1	The utilization of ICT facilities provides mathematics teachers with relevant materials and made them to depend less on textbooks.	07	05	00	20	16	48	3.60	Agree	
2	Mobile phones provide the means for business studies teachers to assess information in other to encourage the students learn independently.	05	04	04	17	18	48	3.81	Agree	
3	The utilization of overhead projector increases the variations to mathematics teaching techniques at reduced cost time and time.	04	06	07	13	18	48	3.73	Agree	3.74
4	Interactive whiteboard facilities help in the representation of lessons better and effective	05	05	04	15	19	48	3.79	Agree	
5	The use of camara encourage teachers to go against the traditional methods of teaching mathematics	05	06	04	14	19	48	3.75	Agree	

Analysis from Table 3 above showed the extent teachers utilize ICT resources in teaching of Mathematics in secondary schools in Uyo Education zone. Respondents Agree with items 1, 2, 3, 4 and 5 with mean 3.60, 3.81, 3.73, 3.79 and 3.75 respectively. No item was disagree. The

pooled mean is 3.74 greater than the stated mean of 3.00. this implies that **teachers' utilization of ICT facilities affect the teaching of Mathematics in secondary schools in Uyo Education zone.**

Research question three

What are the challenges of implementation of ICT tools in teaching Mathematics?

Table 4 shows the challenges of implementation of ICT tools in teaching Mathematics?

S/N	ITEMS	SA	A	SD	D	TOTAL	X	DECCISON
		4	3	2	1			
1	Lack of sufficient computer desktops /laptops.	90 360	76 228	32 64	2 2	200 654	3.3	Accepted
2	Poor electricity supply	85 340	100 300	7 14	8 8	200 662	3.3	Accepted
3	Inability of the teachers to operate ICT materials and transfer knowledge with them.	90 360	104 312	5 10	2 2	200 684	3.4	Accepted
4	Lack of adequate facilities maintenance	87 348	106 318	6 12	1 1	200 679	3.3	Accepted
5	Lack of literacy in internet	87 348	89 267	27 54	9 9	200 678	3.3	Accepted

From the analysis on the above table it can be seen that item 1-5 are all accepted to be the factors hindering the effective implementation of ICT facilities in the teaching and learning of Mathematics with high mean scores of 3.3, 3.3, 3.4, 3.3, and 3.3 respectively which are above the acceptable mean of 2.5 which is the bench mark.

Discussion of Findings

The study examines Implementation strategies of ICT resources utilization and effective pedagogical implication in the teaching and learning of mathematics in Junior Secondary Schools in Uyo Local Government Area.

The finding from table 2 clearly shows that there are availability of ICT resources provided for the teaching of mathematics in school and this is occasioned by the numerous intervention of government programs for students such as the provision of internet facility, computer learning, and online learning classroom which affect students learning of mathematics positively. This finding agrees with the assertion made by Netsianda (2021) who stated that the Internet which is also known as a global system of computer networks and information superhighways have become a very important tool and required by the knowledge-based society present the contemporary for

information management, information search, communication, and research and learning. He went further to add that internet is a rich, multi-layered, complex and ever-changing environment of the text.

Findings from table 3 justifies the utilization of the various ICT resources made available by the government for teaching and learning of mathematics. Results as presented showed the resources made available have been putted into effective usages for teaching and learning to strive. The study further agreed with the findings of (Mueller, 2014). Who opined that computers are instructional tools use for communication, instruction, and evaluation of learning especially in mathematics. It uses a blend of graphs, texts, sounds, and videos for learning process to improve teaching and learning. There further expressed that laptops computers are learner-centered and activity oriented which helps in taking notes enhances better recalling especially if used by students properly, and it promote active learning in a wide variety of disciplines from literature to the social sciences and beyond.

Findings from table 4 justifies the various challenges associated with the implementation of ICT resources made available by the government for teaching and learning of

mathematics. Results as presented showed that lack electricity, unavailability of sufficient computer system, illiteracy on the parts of the mathematics teachers as some of the biting reasons against implementations of ICT resources for effective teaching and learning of mathematics.

Recommendations

Based on these findings, the following recommendations were made:

That there is a challenge of awareness on the part of the teachers on the enormous benefit of ICT resources in helping teachers organize and prepare adequately for classes. Hence, government should organize seminars and workshops to sensitize business studies teachers on the effective usage of e-learning facilities in schools.

Students should be encourage to utilize the internet facilities in their schools as well as their homes in carrying out assignments and home works.

Teachers should allow students do and submit assignments on the varies online learning platforms, this will encourage students to be use to the online learning platform and utilize them maximally.

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COOPERATIVE LEARNING STRATEGY AND SENIOR SECONDARY STUDENTS ACHIEVEMENT AND RETENTION IN MATHEMATICS IN IKWUANO LOCAL GOVERNMENT AREA OF ABIA STATE

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Abstract

This study investigated the effect of Cooperative Learning Strategy on Senior Secondary School Students' Achievement and retention in Mathematics in Ikwuano Local Government Area of Abia State. Quasi experimental pretest, posttest, non-equivalent control group research design was used for the study. Two thousand five hundred and four students formed the population with a sample of 87 students drawn from the population through simple random sampling technique. Instrument used for data collection was teacher made achievement and retention test which covered test items on set theory. 20 objective questions were constructed and validated by experts in mathematics education and measurement and evaluation. The reliability coefficient of the instrument was .79 obtained using Pearson moment correlation techniques. Two research questions were asked; from where two null hypotheses were developed and tested at .05 level of significance. Research questions were answered using mean and standard deviation while Analysis of covariance was used in testing the hypotheses. Results indicated that students who were taught using cooperative learning strategy outperformed their counterparts who used the lecture method in both achievement and retention. Based on the result, it was recommended that teachers should use cooperative teaching/learning strategy in teaching mathematics for better achievement and retention.

Keywords; cooperative learning, achievement, retention, mathematics and strategy

Introduction

The knowledge accumulation we have today increases exponentially as science and technology continue to develop, which is also a transition from industrial society to information society. Within this diverse body of knowledge, science related knowledge plays a very important role especially mathematics. Mathematics knowledge is paramount in the success of every man in his numerous day to day activities. Nkwocha in Salim (2020) viewed mathematics as a science of numbers and systematic reasoning for solving problems. Sidi (2019) had it that mathematics is a knowledge that trains the mind to systematic and critical thinking as well as reasoning. Mathematics education holds the potency of making individuals to relate its knowledge to everyday problem being encountered and hence develop self to a level that one is intellectually and economically stable. Right from the prehistoric days of the early human societies to the present

technological age, mathematics has played a fundamental role in the economic development of many countries of which Nigeria is not left out. Mathematics is important to social, intellectual, spiritual well being of man.

Mathematics as a language of science is a very important subject in our schools as its application cuts across all areas of human endeavor. No wonder Udousoro (2000) affirmed that the knowledge of science remain superficial without mathematics. The pertinent virtue of mathematics as well as its contributions to the development of mankind has earned the subject the prominence it enjoys among other school subjects. It is a core subject in primary and secondary schools in Nigeria, and due to its importance in nation building, the Federal Republic of Nigeria enshrined mathematics in the national policy on education as a core (compulsory) subject for all primary and secondary schools students in Nigeria (FRN,2013). Its inclusion as a pre-requisite for

admission into science and technology based courses in the Nigerian tertiary institutions is basically because of the recognition of the indispensable role it plays in the advancement of science and technology of any nation (Iyekekpolo & Buleis, 2009). As a vital tool for the understanding and application of science and technology, the subject plays the necessary role of a precursor and harbinger to the much needed technological and natural development of the developing nations of the world.

Unfortunately, students' performance in this all important subject has not been impressive as reported by Gakbish, Golji and Augustine (2021) that the study of mathematics in Nigeria is bedeviled by the incessant poor performance of students as a result of poor teaching and learning process. The consistent low achievement of students in mathematics was supported by the works of Bot (2011), Imoke and Agwagah (2012), West African Examinations Council Chief Examiners' report (2018 & 2019) and Eneze, Ezeh and Anibueze (2020) who maintained that even though the indispensability of mathematics in the development of our society has been universally acknowledged, the output of its teaching and learning is still not encouraging. The problem student encounter with topics in mathematics and failure that accompany them have been attributed to the teaching strategies used in teaching the students (Nwagbo & Chikelu, 2011). Subjects such as mathematics in which students think are abstract, ought to be taught with methods or strategies that will make students interact among themselves and teachers. Danmole (2011) noted that teachers need to employ different learning method and strategies to ensure students understanding of scientific concepts.

It is on record that teachers still utilize the traditional strategy of teaching and learning mathematics (Garbett, 2011; Fatade, Mogari & Arigbabu, 2013; Nwoke, 2015, Garba & Salim

2020). Traditional strategy of teaching is popularly known as conventional method of teaching which requires the use of chalk, textbook and the teacher doing most of the talking while the students take note and remain passive. This method of teaching occupies the school system as teachers still use the method in teaching mathematics. Due to the traditional teaching method in Nigeria which is examination oriented, the procedure for the teaching of mathematics is less flexible. The teaching in mathematics classrooms still emphasizes teacher centered, teacher-directed instructions, and teachers still make use of the traditional teaching method where there is a little or no interaction between teachers and students.

In considering ways and means of ensuring effective teaching and learning of mathematics in schools that can enhance students achievement, various teaching and learning methods have been adopted by mathematics educators and researchers, some of which are problem solving, guided discovery, Elaboration strategy, Ethno mathematics among others (Garba & Salim 2020, Debo, Moshood & Nasrudeen 2020, Bitrus, Habila & Thomas 2020) respectively. All these researchers recorded the efficacy of their various methods in teaching mathematics, but still students' performance has not significantly improved. It is based on this that, this study seeks to ascertain if cooperative teaching and learning strategy will have any significant effect on the performance of students in Ikwuano Local Government Area of Abia State since it tends to engage the student actively in the learning process.

Cooperative learning is a method of instruction by which students work together in small groups to reach a common goal. It is a type of learning which takes place in environment where students work collaboratively in small groups by sharing ideas while working on given task. Eniayeju (2010), has it that cooperative learning is a discovery method in which small groups are

used, cooperative learning instructional strategy is the deliberate instructional use of heterogeneous small groups of students who work together to maximize each other's learning (Igboanugo, 2013). Heterogeneity in grouping can be achieved by combining students of different sexes, academic ability level, age's religion among others, so that students can get beyond their initial stereotypes and be able to treat each other as other science students and fellow group members (Igboanugo, 2013).

According to Comparative Education Study And Adaptation Center (CESAC, 2000), Cooperative learning is the type of teaching method in which the goals of the separate individuals are so linked together that there is a positive correlation among the group members for the attainment of their goals; that is an individual obtains his or her goals only if the other members can obtain their goals. Hence, a person seeks an outcome that is beneficial to all those within their initial stereotypes and be able to treat each other as other science students and fellow group members (Igboanugo, 2013). Yash (2011) sees cooperative learning strategy as an instructional strategy whereby students work together in group with a view of completing a specific task or goals, where cooperation replaces competition. Cooperation rather than competition is the predominant characteristics of human beings. A group becomes cooperative learning, if every member of the group knows that he or she cannot be successful unless the other members are successful for a better academic achievement.

Academic achievements according to Central New Mexico (CNM, 2009), is all about what students do when they have finished a course of study. According to Wikipedia (2010), achievement means a thing that somebody has done successfully especially using one's own effort and skill. Academic achievement is the totality of what an individual is able to learn on particular subject contents over a specified

period of time. Academic achievement is measured in relation to what is attained at the end of a course, since it is the level of accomplishment of medium or long term objective of education. This is attained if the learner is able to retain what has been learnt.

Retention is concerned with the ability of the student to retain that which they have achieved for a longer period of time. Retention is defined by Kundii and Tutor (2002) as a preservation factor of the mind. The mind acquires the materials of knowledge through sensation and perception. These acquired materials in the mind needs to be preserved in form of images for knowledge. To develop whenever a stimulation situation occurs retained image are revived or teachers identify the problems of students in the classroom so as to devise means of helping them to achieve. In order to grasp new concepts, students need more time and more repetitions to be successful. The teachers may not have enough time to spend with the students every day. Under this circumstance, cooperative learning strategy on academic achievement of students in mathematics will be investigated.

Statement of the Problem

Mathematics is important in every sphere of life and despite the importance, students academic achievement is disappointing as they are not performing well (Garba & Salim). The present state of mathematics education in Nigeria has been very unsatisfactory, and the poor academic performances of students in mathematics in West African Senior School Certificate Examination (WASSCE) over the years are a proof of this fact. These persistent poor performances of students in mathematics have been attributed to many factors of which method of teaching is one of them. Various methods have been used by researchers to see if the situation will improve but it's not forthcoming. Classrooms are dominated with the lecture method which mathematics teachers are used to. This method that is frequently used by teachers

is teacher centered, so there is need to use method that is student centered to see if students' achievement will improve. Cooperative teaching strategy being a method that enables students to be grouped in small groups and work as a team fits into this category. It is pertinent for this study to therefore investigate the effect of cooperative learning strategy on academic achievement and retention of students in mathematics.

Purpose of Study

This study is designed to investigate the effect of cooperative learning strategy on student's achievement and retention in mathematics. Specifically, the study seeks to find out, the

1. Mean achievement scores of students taught mathematics using cooperative learning strategy and lecture method.
2. Mean retention scores of students taught mathematics using cooperative learning strategy.

Research questions

1. What are the mean achievement scores of students taught mathematics using cooperative learning strategy and those taught using traditional lecture method?
2. What is the mean retention score of student taught mathematics using cooperative learning strategy?

Hypotheses

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

H_{0_1} , there is no significant difference between the mean achievement scores of students taught

mathematics using cooperative learning strategy and those taught using traditional lecture method.

H_{0_2} , there is no significant difference between the mean retention and posttest scores of students taught mathematics using cooperative learning strategy.

Methodology

This study employed a quasi experimental pretest-posttest control group research design. The population of the study was all the senior secondary school students in Ikwuano Local Government area of Abia State made up of two thousand, five hundred and four senior secondary two students in Abia State with a sample of eighty seven students drawn through simple random sampling technique was used for the study. The instrument used for data collection was researchers' developed achievement test. Validation of the instrument was carried out by three experts in the Department of Science Education. Data collected were analyzed using mean and standard deviation for research questions and analysis of covariance for hypotheses at 0.05 level of significance.

Results

The data were analyzed and the result presented according to research questions and hypotheses.

Research question 1: What are the mean achievement scores of students taught mathematics using cooperative learning strategy and those taught using traditional lecture method?

Table 1: Means and standard deviations of students taught mathematics using cooperative learning strategy and those taught using traditional lecture method?

Teaching methods	N	Pretest		Posttest		Mean difference
		Mean(X)	std.dev	Mean(X)	std.dev	
Lecture	42	17.29	0.86	27.67	0.79	10.38
Cooperative	45	18.01	0.78	31.73	0.84	13.72

Table 1 showed the means and standard deviations of students taught mathematics using cooperative learning strategy and those taught using traditional lecture method. Students taught using lecture method had means and standard deviation of 27.67 and 0.79 respectively and students taught using cooperative method had mean of 31.73 and standard deviation of 0.84. This indicates that students taught mathematics using the

cooperative teaching strategy achieved better than those taught using the traditional teaching strategy.

Hypothesis 1: there is no significant difference between the mean achievement scores of students taught mathematics using cooperative learning strategy and those taught using traditional lecture method.

Table 2: ANCOVA analysis of the mean achievement scores of students taught mathematics using cooperative learning strategy and those taught using traditional lecture method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	1477.374 ^a	2	738.687	18.401	.000	S
Intercept	8000.436	1	8000.436	199.299	.000	S
PRETEST	2.327	1	2.327	.058	.810	NS
Strategy	1351.713	1	1351.713	33.673	.000	S
Error	3251.578	81	40.143			
Total	51024.000	84				
Corrected Total	4728.52	83				

N= Significant NS = Not Significant

Table 2 showed the F-ratio of 199.299 for groups with P-value of .000 which is less than the significant value of .05. The null hypothesis of no significant difference is therefore rejected which indicates that there is a significant difference among the strategies.

Research question 2. What are the mean retention scores of students taught mathematics using cooperative learning strategy.

Table 3: Means and standard deviations retention scores of students taught mathematics using cooperative learning strategy.

Teaching Method	N	Posttest		Retention		Mean diff
		Mean(X)	std.dev	Mean(X)	std.dev	
Cooperative	45	31.73	0.84	34.87	0.79	3.14

Table 3 showed the means and standard deviations of the retention scores of students taught mathematics using cooperative learning strategy. The posttest had mean of 31.73 with standard deviation of .84 and retention mean of 34.87 with standard deviation of .79. The mean difference is 3.14. This indicates that the means were not far from each other which indicate that students retained what they were taught.

Discussion of findings

The findings of this study revealed that students who learnt through cooperative learning strategy performed better than students who learnt through traditional lecture method. Students as well retained what they learnt through cooperative learning strategy as shown in the posttest-retention means. The study showed that there is a significant difference between the mean achievement scores of students taught mathematics using cooperative learning strategy and those taught using traditional lecture method.

This work is in consonance with that of Tobih (2017), Iji, Udenyi, and Uka (2021) whose studies indicated that students who learnt through cooperative learning strategy outperformed their counterparts both in

achievement and interest. This implies that cooperative learning strategy has been found to foster high academic achievement in mathematics.

Conclusion

From the research findings of this study it is clear that Cooperative learning strategy has proved to be effective in teaching and learning of mathematics and should be adopted in schools for teaching mathematics especially geometry.

Recommendations

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

- 1) Mathematics teachers at secondary school level should apply cooperative teaching and learning strategy to enhance students achievement in mathematics
- 2) Students should as well form small groups and use it to practice cooperative learning even when no teacher is involved.
- 3) School administrators should enforce the use of cooperative strategy in schools since the efficacy in both achievement and retention has been ascertained

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MATHEMATICS EDUCATION FOR SUSTAINABLE DEVELOPMENT IN SCIENCE AND TECHNOLOGY TOWARDS SOLVING INSECURITY AND ECONOMIC PROBLEMS IN NIGERIA

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Abstract

This paper discussed mathematics education for sustainable development in science and technology in Nigeria towards solving insecurity and economic problems in Nigeria. The significance of mathematics education in science and technology development in the 'developed', 'developing' and 'under-developed' nations of the world is quite glaring which was why it is made compulsory at the primary, secondary and some courses in tertiary institutions in Nigeria. This paper considered mathematics education for maintenance of scientific and technological development in Nigeria. Issues such as the concept of sustainable development, the importance of mathematics education, the positive impacts of science and technology were delved into. This paper also discussed the principles behind the actualization of sustainable development in science and technology using mathematics education as a tool. Hence, Suggestions on how problems in mathematics education could be solved were proffered.

Keywords: Mathematics Education, Sustainable Development, Science and Technology, Insecurity, Economic problem.

Introduction

The foundation and most effective tool for development and its sustainability in every sphere of a country and the entire planet is widely acknowledged to be education. It is a tool for relative change that fosters development and provides the learner with pertinent information for improvement on the personal, societal, and global levels. The supply of Education to the citizen of a country is the key to development and it is sustainability of such country (Aldon et al, 2021).

Mathematics education is the practice of promoting the dissemination and acquisition of mathematical knowledge by trained educational personnel. It is a way of teaching and learning mathematics that helps students develop the abilities they need for other subjects. The study of mathematics lays the foundation for science, technology and engineering, both of which are essential for the development of any civilization (Oredein & Sam-Kayode; 2022). Both educated and less-skilled people frequently use mathematical terminology to conduct everyday business in many spheres of human endeavor, including markets, politics, economics, and

health sector. The National Policy on Education (2013) published by the Federal Government, outlined the objectives for mathematics education in Nigeria. Among these objectives are the provision of technical skills for self-reliance in agricultural science, industry, and economic development; the provision of well-trained individuals capable of thinking independently, rationally, and with respect for others' opinions as well as the dignity of labour; the provision of trained manpower in the applied sciences, technology, and engineering; and the provision of well-trained individuals in the humanities; encourage students to strive for excellence and self-improvement; provide a diversified curriculum that will account for differences in talents, dispositions, opportunities, and future roles; foster patriotism, national unity, and security education with an emphasis on the common ties in spite of our diversity; encourage people with a basic certificate to work and contribute to the national and global economies through entrepreneurial, technical, vocational jobs for sustainable development; and promote Nigerian culture, arts, and culture in the context of global

economy. Mathematics education, which forms the basis for other disciplines that foster development, is intended to achieve these goals.

The Sustainable Development

The United Nations coined the term "sustainable development" to refer to challenges involving both human and land development, including standard of living, public health, and education. It is a guiding principle for achieving human development objectives while preserving the capacity of natural systems to deliver the natural resources and ecosystem services that are essential to the economy and society. A state of society where living circumstances and resources are used to meet human needs while maintaining the integrity and stability of the natural system is the desired outcome. A development that can both meet the demands of the present and those of future generations is said to be sustainable. It also refers to the act of preserving productivity by substituting old resources for new ones that are of equal or greater value while preventing the degradation or endangerment of biotic natural systems. Precepts and partnerships for sustainable development have been identified, including those for environmental protection, social development, and economic development. A general definition of sustainable development is a systems approach to growth and development as well as managing natural, produced, and social capital for present and future generations. It takes people who can act sustainably in difficult circumstances while taking the short- and long-term into account and recognizing the social, cultural, and economic repercussions (UNESCO 2019). Since mathematics has worth beyond only its practical applications, it may and should become a vital tool for building personalities. The application of mathematics' worldview, moral, educational, and aesthetic purposes demonstrates its humanitarian potential, which is not significant. The creation of a worldview might be seen as the primary objective of mathematical education in the

context of sustainable development (Hassan, 2019).

In this modern age, mathematics education is the driving force behind change. It is a method of enhancing productivity and guiding students toward practical subject mastery; its application will give people a vocation rather than opening doors for job seekers because science and technology are mathematics-oriented and include a wide range of trades and careers Gellert, Jablonka & Keitel (2013). Through training, people are supported in developing their abilities, promoting and establishing small and medium-sized businesses, gaining access to opportunities for earning money, and finding gainful employment. As a result, the Science and Technology on which mathematics is based are tools for generating riches. According to Tsafe (2014), mathematics is crucial to all human endeavors and cannot be ignored whether making decisions, carrying out projects, implementing policies, or conducting studies. The secret to development is mathematics. The importance that mathematics plays in everyday human actions suggests that everyone needs mathematics, not just for scientific or technological progress but for all types of development. Mathematics is a crucial part of people's daily lives with numerous applications in various fields such as architecture, art, computing, engineering, sports, and business (Akinsola, 2023). Having a proper understanding of Mathematics is an important characteristic that can help people to become more productive, reflective, and engaged members of society. In technology, geometrical constructs encourage physical work through mathematics. A student may be able to develop into a valuable, practical, and diligent member of his/her community and thereby create a career for him/herself and others if they are exposed to enough mathematics activities that call for manipulating abilities which makes them to be financially secured thereby freeing their minds of all social vices.

Importance of Mathematics education in science and technology.

Science and technology both require the capacity for computation, and as such, these two variables require the assistance of mathematical education. Science and technology has varied models to suit each country as it can resolve and clarify various complex issues for commerce and industries. Such mathematical and scientific knowledge will enhance new value for society and give young people the opportunity to develop different skills. A well implemented science and technology program will aid the expansion of economic activities of the nation and equip the youths with the knowledge and skills that will enable them compete favorably in the technologically driven globalized societies. Thereby offering graduates with adequate training that will enable them to be creative and innovative in identifying novel opportunities and providing them with adequate training in risk management (Onwu & Ikegwu). There are fewer students in science, especially pure science, than one might expect because many students fear mathematics. Any country that wants to advance technologically needs a scientific foundation that calls for the application of mathematics (Boaler, 2018). Nigeria might profit from the goods produced by other developed nations because their technological advancements are rapid. Daso (2013), stated that scientific and technological advancements have a significant impact on revolutionizing many of humanity's industrial and social activities. If this claim is true, One would agree without a doubt that proper mathematics education is necessary for the advancement of science and technology. The so-called 'developing' countries of Africa may have achieved progress, but maintaining that development is the key concern. Furthermore, since mathematics is the foundation of science and technology, the level of understanding among Nigerians is a critical problem for the sustainability of science and

technology development. This worry is caused by the fact that the sustenance of the science and technology development thus far becomes a phantom as the level of mathematical proficiency among Nigerians continues to be low (Awofala & Fatade, 2017). This indicates that the Nigerian populace needs to be extensively educated on the importance of mathematics

Positive effects of Technology and Science in Nigeria

Our cultures have been significantly touched by science and technology. According to Anaeto el ta (2016) and Ukozor (2022), the following Nigerian industries have profited most from science and technology.

1. Agriculture: Subsistence farming predated colonialism, but agricultural systems now are highly commercialized. Our agricultural sector has been strengthened and made more commercially viable for trade across international borders thanks to tractors, ploughs, planters, ridgers, harvesters' machines, and fertilizers. Additionally, the development of storage and transportation tools like silos and refrigerators has helped keep perishable agriculture products like salmon, tomatoes and other vegetables fresh for consumption. The development of genetically modified plants, such as potatoes, that are resistant to pests and illnesses has also been made possible by science, sparing farmers from using excessive amounts of pesticides. Animal raising has become easier thanks to science and technology thanks to the creation of feeds like blood meal, fish meal, and layers feed. Additionally, animals created genetically through animal cross-breeding have helped to generate stronger and more effective animals.

Irrigation is a further area where science and technology have an impact on agriculture. Farmers in the north may now sow crops all year round because to irrigation.

2. Entertainment: Thanks to science and technology, Nigeria's entertainment sector has recently seen significant progress. The digitization of music and video has boosted Hollywood's financial performance. The introduction of Smartphone technology has transformed the entertainment industry, including high-definition video material, CD players, DVD players, and tape and video cassettes.

3. Finance: Science and technology have impacted Nigeria's financial system, changing how the financial sector operates. Without science and technology, it would not have been possible for things like mobile banking, Automated Teller Machines (ATM), e-payments and fund transfers, online banking platforms, ICT integrated project banks, electronic mail for customer updates, banking automated clearing services for clearing of cheque transactions, and various Financial Tech functionalities to exist today. The financial system in Nigeria is rapidly becoming more centered on the client.

4. Production procedures: In the manufacturing, wholesale, and retail sectors, science and technology have boosted the speed, efficiency, and adaptability of production procedures. Nigerian producers and retailers can set up ties with clients and produce a wide variety of goods. The coordination of the manufacturing processes in Nigeria has improved because to technologies like intranets, extranets, resource management, accounting systems, online purchasing, supply chain management software, 3D printing, industrial robotics, advanced data analytics, and predictive technologies.

5. Telecommunications:

The telecommunications sector in Nigeria has been significantly impacted by science and technology. The internet and mobile broadband technologies are two notable inventions.

The transition from 2G to 3G to 4G and soon to 5G mobile broadband has been slow. Thanks to science and technology, local and international calls can now be made on more affordable tariff rates. Furthermore, unlike the days of the post

office and letters, social networking sites have made communication simpler and faster. Additionally, the financial industry and telecommunications technology are working together to promote financial inclusion for all through mobile banking and other e-payment platforms.

6. Exploration of Oil and Gas

Nigeria's principal sources of income are overly dependent on oil and gas. Nevertheless, we continue to transport our crude oil abroad for refinement. Better methods for drilling and producing different types of crude oil components have been developed by science and technology, which we are incorporating into the design of our refineries. New technologies, such as flexible drills, 4D seismic monitoring, and hydraulic fracturing in oil and gas exploration, have improved oil field monitoring, allowed access to shale gases, sustained production in exhausted oil fields, and produced environmentally friendly goods.

7. Construction

With the aid of fantastic machines created by science and technology, Nigerian building sites are today more productive. To deter vandalism and enhance machine functionality, machines are equipped with bar codes, QR codes, and telematics. Drones, 3D printing, smart meters, robotic exoskeletons, and wearable smart sensors are other significant impacts of science and technology on the Nigerian construction sector.

8. Health: Medical assistants and health information technicians can now quickly access patient records, digitize health records to a central database, give data for study, and notify doctors of potential health risks through the help science and technology. Additionally, technologies like artificial insemination, incubation, and Caesarean sections for pregnant women have made deliveries of healthy babies ease. Technologies like X-rays, photo-scans, and electrocardiograms have helped with diagnosis and therapy. Technologies are improving Nigeria's healthcare system.

9. Transportation: Without transportation, what would Nigeria be like? With the development of good road networks connecting all the states in Nigeria as well as the creation of ships, airplanes, helicopters, cars, trains, motorcycles, and tricycles to transport people, goods, and services across the nation, science and technology have expanded the scope of our transportation industry. A monorail is now being built to serve as transportation as well.

10. Education: Technology has significantly improved human capital development. The educational system in Nigeria has developed to provide personalized learning, improved research, distance learning, and value-added learning opportunities targeted at creating well-rounded individuals. The educational industry in Nigeria has been significantly impacted by educational technology.

11. Research and Development

Nowadays, we live in an information society. Technology gives researchers proof for using cloud computing to disseminate study reports and discoveries.

The abundance of articles on the internet about every facet of life makes research easier. Every subject of research has news about recent developments published online. This has increased our understanding of a variety of topics.

12. Worldwide Cooperation

Nigeria has been able to conduct business across international borders, win respect from other countries, and actively work with them thanks to science and technology. Consider what would happen if there was no technology: there would be no distance learning, no communication with the outside world, no access to numerous technologies, and we would still be living in the Stone Age. As a result, although as a country we have left our formal position of progress through advancement in science and technology, we have not yet reached where we are heading. Therefore, there is a need for sustainable development in science and technology through mathematics education in order to stop the

deterioration of our current state and to allow improvement in science and technology to be named among the developed countries in the future (Subramaniam, 2021).

Using Mathematics Education to Realize Sustainable Development in Science and Technology

More than 90% of scientists, according to Daso (2013) the general public's current level of awareness of science, its processes, and its effects is sufficient. Only 32% of American parents surveyed, according to him, believed they were science literate. The worrying fact is that only 36% of the teachers polled thought they were literate in science. He asserted that the situation in Nigeria is even scarier than what we are now witnessing.

On this basis, it was noted that workers in the twenty-first century need not only a larger collection of facts or a wider range of specialized skills, but also the ability to quickly pick up new information, tackle brand-new challenges, and apply creativity and critical thinking to the development of novel solutions to old problems. Daso (2013) noted that there was no political or public support for our goals to improve scientific literacy, technological effectiveness, and mathematics skills in our educational system. It was stated that the development of skilled labor in science and technology for the various facets of national development should be regarded as a national priority issue (Daso 2013). This is true, so that the individual can classify experiences, arrange human concepts and attitudes, and interact with others. Science and technology education gives these tools.

Since mathematics educators are primarily responsible for the development of science and technology, their deficiencies in both qualitative and quantitative forms are of concern (Daso, 2013). Daso (2013) observed that there is a need for mass production of mathematics teachers, both numerically and qualitatively, in order for science and technology to be sustained. This may be the case because mathematics professors

place a strong emphasis on scientific and technological literacy by requiring students to take an objective and unbiased view of research, technology, and society's effects. Functional, pertinent, and linked mathematics can help advance society's technological and scientific progress (Saward, 2017; English, 2019; Shulla el ta, 2020)

Positive effect of Mathematics Education on insecurity and economic problems

Mathematics is the most important factor of the technological changes which occurs in the modern world around economic development of any nation. It is fundamental in providing solution to economic problems by revising economic recession and proper allocation of resources (Agbajor, 2013; Etukudo, 2017; Guwam, 2017). Also, the knowledge of concepts like geometry and trigonometry are rapid in professions like architecture, surveying, building, modeling, sculpturing and medicine which consists larger part of the national development and invariably the economic development of the nation.

National security was alleged to as the building up of defense and security manpower and gathering or collecting weapon systems for the state to meet security challenges in the face of threats. Mathematics principles and physics is employed in solving difficult civil and security problems with the use of wavelet transformation and powerful statistical tool which can be used for a wide range of applications in signal processing, data compression, wave propagation, image processing, pattern recognition, detection of aircraft and submarines, fingerprint for detecting the properties of quick variation of values, internet traffic description for designing the services size, industrial supervision of gear-wheel and computer graphics and multi-factual analysis which are all wavelets process complex information pasted at different positions (Zakariya & Bawa, 2013). Mathematics skills is needed in identification of numbers and proper value identification of numbers and proper

value identification of numbers and proper value identification of money in the bank, ATM and financial houses to detect fraudulent acts arising from financial insecurity (Jiang, 2013).

Conclusion

This essay critically analyzed how mathematics education has impacted the advancement of science and technology towards solving insecurity and economic problems in Nigeria. The use of technology and science in sustainable development was considered. It highlighted the good effects of advancements in science and technology that needed to be sustained if well sustained, will improve the economic situations in the country and put an end to the social vices which can lead to insecurity problem.

Suggestions

In this paper, the intimate character of teaching in science, technology, and mathematics towards solving insecurity and economic problems in Nigeria was discussed. Because it's easy to maintain what one already has as it's prefer to seeking out a new one that can be more costly and time-consuming, the following were suggested:

1. Increase in number of qualified mathematics teachers in the educational systems by encouraging students to study Mathematics Education at the College and in the University
2. Provision of in-service training that is specifically related to science and technology for all mathematics teachers
3. The development of the mathematics curriculum shouldn't be left entirely in the hands of mathematicians; rather, it should involve political organizations, parents, government officials, and other scientific and technology stakeholders.
4. Provision of the required facilities, including a well-equipped mathematics laboratory, science laboratory, and other facilities needed for efficient teaching and learning of mathematics and sciences

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