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MATHEMATICS EDUCATION: TOOL FOR SECURITY AND NATIONAL DEVELOPMENT.

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Abstract

The world today due to the technological advancement is filled with insecurity which poses threats of different forms to human lives and properties. Security is needed to assuage these threats to lives and properties and maintain safety, survival and national development. This paper examined mathematics education as tool for security and national development. It begins with the meaning of security, three levels of maintaining security and four elements comprising effective security system. Further, it expatiated mathematical skills useful in solving problems and understanding the world. Finally, it examined four aspects of mathematics application in ensuring national security and development. It is therefore recommended amongst others that there should be regular review of mathematics curricular at all levels of education to incorporate more feasible mathematical skills and techniques useful in adapting to the advancements in the world and tackling insecurity in Nigeria.

Keywords: Mathematics education, mathematical techniques, security, national development

Introduction

The rising technological advancement witnessed in the modern world today facilitated by developments such as globalization and the spread of networked and higher-connected technologies has been accompanied by different security and safety challenges such as cyber crime, terrorism and environmental disasters posing threats to human lives and properties across the globe, the educational institutions not left out (Berg & Prins, 2023; Narasimman, 2023). Understanding the need for security measures and procedures is essential to every organisation in order to protect sensitive information, recognise and respond to potential threats, and prevent future attacks that may pose harm to the organisation and its stakeholders (Hse, 2023).

Security is simply safety and protection from threats to survival, daily life and dignity of human beings (Degaut, 2016). However, security has been defined variously from different perspectives at different times. Meerts (2018) defined security as "a state of being free from many kinds of dangers and threats (e.g. war, unemployment, illness, or accidents)". Afolabi (2016) asserts that security entails the presence of peace, safety, gladness, human and physical resources, protection or absence of threats to human dignity resulting in the development and progress of the human society. In sum, it is a process of avoiding threats to life and properties of precious values.

One of the challenges faced in institutions of learning amongst others is insecurity (Jacob, Jegede & Musa, 2022). Aside the attack from terrorist groups such as Boko-Haram, herdsmen militia, and so on; insecurity has been experienced in the area of attack to data and information. The introduction of advanced learning gadgets, the internet and globalization contribute to making students very smart in learning, insecurity is thus a major challenge in Nigeria and institutions of higher learning have not been spared. Kpee and Osiobe (2014) asserts that all aspects of the society including public institutions such as schools, churches, mosques and gatherings of people for different purposes are prone to insecurity.

Cyber security challenges have developed in a bid to respond to this new world, which is also witnessed in the educational institutions. There is therefore the need to develop the means of tackling these security challenges to ensure safer cyberspace and society at large. Narasimman (2023) defined cyber security as the process of protecting the networks, computers,

servers, mobile devices, electronic systems and data against threats and malicious intrusions otherwise referred to as information security. Viruses, worms, spyware, Trojans and ransom ware are the common methods used by attackers to control computers and networks. This process is essential in curbing major challenges such as theft and destruction of different data types comprising sensitive information. Industries using networks are being affected by cyber security threats such as the healthcare, finance, manufacturing and government.

This article therefore discusses the following: the three levels of maintaining security; four elements comprising effective security system; mathematical skills useful in solving problems; and four roles of mathematics in different areas of security.

Three Levels of Maintaining Security

Buzan (1991, as cited in Afolabi, 2016) identified three levels of maintaining security namely individual, national and international, regarded as human security, national and international security respectively.

The human security is concerned with the safety and protection of human lives, properties and dignity. This is categorized into seven dimensions reflecting the key components of human development namely: economic security implying assured basic income which is the protection from threats to basic income such as poverty, unemployment, indebtedness and lack of income; food security implying physical and economic access to food, that is, the protection from threats to food availability and accessibility; health security implying access to medical treatment and improved health conditions, that is, the protection from threats to human life such as diseases, unhealthy lifestyle and death; environmental security which is living in a healthy physical environment, implying the protection from threats against the natural environment such as natural disasters and pollutions (air, water and land) endangering human survival; personal security referring to protection of individual lives from every form of physical violence and threats to self such as suicide, drug abuse, etc.; community security entailing the protection from threats due to violence from any of the social groups such as family, community, ethnic group, etc.; and political security which is the protection from threats against the fundamental human rights of the citizens (Afolabi, 2016; Hussein, Gnisci, & Wanjiru, 2004).

National security on the other hand, is described as the protection of a nation's interest against internal threats and challenges while the international security entails the safety of the vulnerable from different parts of the world and protection of nations/states from deprivations of different kinds such as social, economic and political deprivations (Afolabi, 2016).

Four Elements which form Effective Security System

Forsyth (2019) emphasized four elements composing an effective security system namely protection, detection, verification and reaction applicable to all organisations. Protection entails the act of creating barrier to defend against threat, intrusion or trespass on properties. Detection is a form of security (such as, technology) which alerts one of any form of intrusion or threats. Verification is a security mechanism that verifies the exact level of threat posed while reaction is the response to any form of intrusion events detected and verified.

Mathematics Skills Useful in Solving Problems

Mathematics has been viewed as an effective tool in tackling security problems and solving crimes via various skills it develops in students having effect on national development (Charles-Ogan, 2014). In other words, mathematics has the potency of improving a nation economically, socially and politically in order to enhance the standard of living of her citizens. Mathematics is crucial in solving Nigeria's security challenges as well as ensuring her prosperity (Odeniyi, 2023). Sa'adatu (2014) opines that mathematics education is a major instrument in tackling security challenges being faced in Nigeria because of the skills it develops in tackling real life problems. It has to do with reasoning and not memorisation and develops both analytical and problem solving skills which aids the development of the following abilities: the ability to think creatively, critically and logically; the ability to structure and organise; ability to process information; enjoyment of intellectual challenges; the skills to solve problems useful in investigating and understanding the world (Klerlein & Hervey, 2023).

Roles of Mathematics in different Areas of Security

Aspects of mathematics application in ensuring national security include:

Cryptography (Data Security)

Cryptography is the process of keeping data confidential and maintaining its integrity via the use of codes to secure communications among computer systems, devices and applications (RSI Security, 2022). It is a tool used in securing sensitive data transmission over the networks and Information Technology (IT) infrastructure making it difficult for attackers to read the information even when compromised. Thus, it protects sensitive information from threats of unauthorised access without the key used in encrypting and decrypting data. Two primary methods of cryptography in securing data are: encryption and decryption (RSI Security, 2022).

Data encryption is the process of using mathematical algorithm in converting plaintext (ordinary or clear text) into ciphertext (difficult to decipher form) which can only be accessed using cryptographic key. This secures data transmission and minimizes the risks of data being compromised.

Decryption is the process of reversing encryption using a cryptographic key matching the encryption algorithm. Algorithm is a mathematical concept containing series of mathematical operations used for cryptographic key generation, digital signing, verification to protect data privacy, web browsing on the internet and confidential communications such as credit card transactions and emails (Richards, 2021).

Cryptography is useful in securing sensitive emails containing sensitive data; encrypting databases containing sensitive information; protecting sensitive company data; and encrypting HTTPS (Hypertext Transfer Protocol Secure) to secure websites URL (Uniform Resource Locator) using the HTTPS protocol to safeguard the confidentiality, integrity, and authenticity of transactions on the internet.

Two types of cryptography used for cyber security applications are symmetric and asymmetric cryptography. Symmetric cryptography otherwise called secret key cryptography permits the sharing of same cryptographic key used in encrypting and decrypting data between users. It is usually used in securing local storage of sensitive data on drives or servers. On the other hand, asymmetric cryptography is used in securing the transmission of sensitive data across public networks having two keys otherwise called public key cryptography. One key is private key used in encrypting or decrypting data while the other is a public key supplied to anyone being communicated with by either of the users (RSI, 2022).

Hence, mathematics via algorithms helps in securing the transmission of sensitive data over the internet networks between or among users.

Financial Security

Ahmad and Sabri (2014) defined financial security as the state of having constant income or other resources (assets, wealth) for sustaining the present and future standard of living. Securing one's financial well-being is an essential necessity in life. Mathematics is useful in making financial plan (to ensure expenses don't exceed income) and resolving financial issues in order to secure the financial future of both individuals and organisation (U.S. Securities and Exchange Commission, 2023).

Financial security utilises mathematical techniques, formulas, equations and models in identifying, managing and resolving financial problems and threats in the financial field. Mathematical models are essential in studying specific financial problems, analyzing and solving financial problems in a scientific and convenient way based on the functional relationship between variables. Mathematics is also useful in risk management in analyzing market data, finding patterns in data and predicting risks. Aspects of mathematical concepts applicable include probability theory, calculus and so on.

Hence, mathematics helps in building and managing financial resources, protecting against major economic shocks and building wealth.

Food Security

Food security has been defined as “when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (The World Bank, 2023). It implies the protection from threats against the production, availability, accessibility and consumption of good and healthy food.

Three components of food security include: the availability of sufficient quantities of appropriate food, accessibility to adequate income or resources to obtain quality food, and utilisation that is the consumption or absorption of nutrients in the food.

Mathematical approaches are needed to optimize agriculture in order to produce more resilient crops through selective breeding and genetic modification. Ensuring food security promotes sustainable development, trade and a healthier environment. This is possible via the utilisation of complex mathematical modeling or applied mathematics and efficient mathematics skills to boost productivity. Mathematics also enables the gathering of relevant data on how to increase production and meet the ever-increasing global demand for food (iCrowdNewswire, 2021). Mathematics skills and models can be applied to assess the possible outcomes of any course of action taken in the agricultural field which in essence increases the success of agriculture by enabling the making of more favourable decisions.

Economic Security

Economic security is defined "as the ability of individuals, households, and communities to meet their basic and essential needs sustainably: including food, shelter, clothing, healthcare, education, information, livelihoods and social protection" (GSDI, 2023). It is simply the protection against the threats to accessing basic social security that is, basic and essential infrastructure such as inequalities in education, health and employment (that is unemployment) which are threats to sustainable national development.

Bamigbola (2021) emphasized insecurity as one of the problems against realizing optimal national life amongst others which can be resolved using "techniques of mathematical optimization" in order to enhance the nation's economic fortunes. Hence, he emphasized system's improvement and wastage elimination as two essential strategies utilised in mathematical optimization.

Conclusion

This paper examines the application of mathematics as a tool for maintaining national security and development. The insecurity challenges experienced against information, finance, food and economic can be resolved using mathematical approach, that is, mathematics techniques and models, thus enhancing safety of lives and properties, survival and national development.

Recommendations

1. More mathematics experts should be involved in tackling the security matters in the nation, Nigeria.
2. Mathematics curricular at all levels of education should be regularly revised to incorporate more feasible skills that are useful in adapting to the advancements experienced in the world today so as to tackle the insecurity encountered in the nation.
3. Government should invest financially in the training of mathematics experts so as to acquire advance skills in tackling complex security issues in the country.

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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 over emphasize.

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 OF TEACHERS		
		MALE	FEMALE	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 where collected latter 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 retuned for those teachers who teaches both junior and senior secondary sections. This gives the total of thirty (30) retuned 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 mage not covered and almost covered as not covered, not necessary and not quit necessary as not necessary.

For analyzing the hypotheses, the row 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; bout 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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MATHEMATICS PROFICIENCY FOR SECURING NATIONAL DEVELOPMENT; A LATTICE - MULTIPLICATION STRATEGY IN TEACHING MULTIPLICATION ON SECONDARY SECHOOL STUDENTS PERFORMANCE IN ZARIA METROPOLIS, NIGERIA

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Abstract

Mathematics is a compulsory subject at the secondary school level but the level of performance of students in the subject has remained a major source of concern to academics and other well-meaning Nigerians. This study was conducted to determine the Use of Lattice-Multiplication Strategy on performance in multiplication of two and multi-digit numbers among junior secondary school students in Zaria metropolis, Kaduna State. The sample for the study consists of 102 students (64 male and 48 female) in the JSS 1II level randomly selected from the population of 1250 students in twenty eight Government Junior secondary schools. Two Research questions and two Null hypotheses were formulated to guide the study. Two schools were random selected of which one is used for experimental group and the other for control group. Experimental group were exposed to Lattice-Multiplication Strategy while control group were exposed to Conventional (Standard multiplication algorithm method). Multiplication Concepts Performance Test (MCPT) items was used for both pre-test and post-test as the instrument for data collection. The data collected were analysed using mean, standard deviation to answer research questions and t– test analysis was used to analyse hypotheses each tested at 0.05 level of significance. The findings revealed that there is significant difference between the performance of students exposed to Lattice-Multiplication Strategy and their counterpart exposed to Conventional Method in favour of experimental group so the findings revealed that there is no significant difference between male and female student's performance on multiplication of two and multi digit numbers using Lattice-Multiplication Strategy. Hence the researcher recommended that the use of Lattice-Multiplication Strategy should be adopted for teaching/learning of Multiplication concepts in the junior secondary schools, In-service training programmes for Mathematics Teachers in form of workshops, seminars and conferences should be organised to focus more on how to use in Teaching Mathematics concepts, among others.

Keywords: Lattice-Multiplication Strategy, Standard Multiplication algorithm Method (Conventional), performance, Multiplication of two and multi-digit numbers.

Introduction

Mathematics is primarily concerned with ideas processes and reasoning leading to the solution of problems. It is widely recognized as a necessary tool for achieving the development goals of any society. Good knowledge of mathematics implies the growth for secure and sustainable development of a nation. Teaching and learning of Mathematics, science, and technology form the bedrock that provide the springboard to growth development for the developing nation like Nigeria. Eniayeju (2010), Affirmed that the sustainable development of any nation depend on the degree and extend of the socio-cultural, social economic and political improvement that brought about entrepreneurship of science, technology and Mathematics education. Mathematics plays an important role as the gateway to other fields of endeavour or sectors such as Health, Agriculture, Political science, Culture, Economy, Educational and other sectors. It has a pride of place in the global world and in nation building as regards to its contexts and applications to real life situation. The need to acquire knowledge in Mathematics in the world over has become very

obvious, because it is relevant to everyday experience in our society. As a follow up, it has been a compulsory subject both at primary and secondary level of education in Nigeria. (FGN, 2013)

Furthermore, the influence of gender variation on students Mathematics performance is still a major controversy among researches. This may be as a result of conflicting results from such gender related studies. Some research results find significant difference in favour of males as in (Onasanya, 2008: Shafi & Areelu, 2010) and Frederich-Jonah & Akinsola (2015) are in favour of females. And others like Eniayeju (2010), Nasiru & Binji (2016) are in neutral. This controversy in the test of performance between males and females in mathematics need further investigation in the use of Lattice-Multiplication Strategy to enhance mathematics proficiency in multiplication at secondary school level. Thus, is against this background the researcher intends to investigate the impact of Lattice-Multiplication Strategy on performance in multiplication of two and multi-digit numbers among junior secondary school students in Zaria Metropolis.

Multiplication is a Mathematical operation performed on a pair of numbers in order to derive a third numbers called a product. For positive integers, multiplicand consists of adding a number (the multiplicand) to itself a specific number of times. For instance 6 by 3 means adding 6 to itself three times. Multiplication is represented by a symbol (X) sign cross or (.) dot. The number of objects in each group is called multiplicand and the number of such groups is called multiplayer. Multiplication has three properties which includes commutative (a x b = b x a), associative a x (b x c) = (a x b) x c and distributive a x (b + c) = (a x b) + (a x c) properties respectively. In multiplication, if we multiply a number by one, the product remains the same number. One is the identity element under multiplication and also if we multiply a number by zero, the product is zero.

Lattice multiplication is known as the Italian and Chinese method of multiplication that uses a lattice to multiply two multi-digit numbers. It is mathematically identical to the more commonly used long multiplication algorithm, but it breaks the process into smaller steps, which some practitioners find it easier to use. This method has been used for centuries in many different nations. It is still being taught in certain curricula today. Historically lattice multiplication was used by Arabs, European and Chinese mathematicians. There is the need therefore to apply it in Nigeria to find out of global implication.

How to Use Lattice- Multiplication Strategy

A grid is drawn up, and each cell is split diagonally. The two multiplicands of the product to be calculated are written along the top and right side of the lattice respectively with one digit first column across the top to first. Multiplicand (the number written left to right) and one digit per-row down the right side for the second multiplicand (the number written top down), then each cell of the lattice is filled in with product of the column and row digit. (Thomas, 2005 and Bong, 2007).

For example, let consider the multiplication of 58 with 213

Step One:

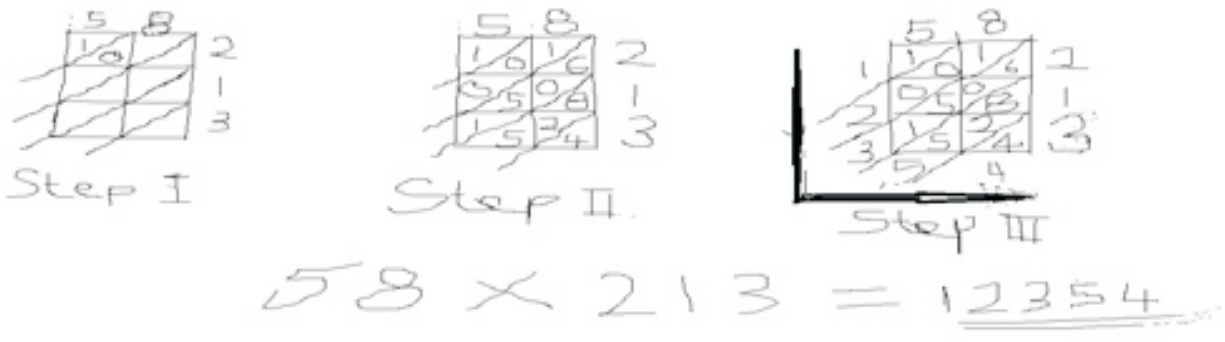
After writing multiplicands on the sides, consider each cell, beginning with the top left cell. In this case, the column digit is 5 and the row digit is 2. Write their product, 10, in the cell, with the digit 1 above the diagonal (see step one below). Note also that, if the simple product lacks digit in the tens place, simply fill in the tens place with zero o. (See step 1 in picture 1)

Step Two

After all the cells are filled in this manner, the digits in each diagonal are summed, working from the bottom right diagonal to the top left. Each diagonal sum is written where the diagonal ends. If the sum contains more than one digit, the value of the tens place is carried into the next diagonal (See Step 2 in picture 1).

Step Three

The numbers are filled to the left and to the bottom of the grid, and the answer is the numbers read off down (on the left) and across (on the bottom). (See Step 3 in picture I)



Picture 1

Multiplication of decimal fractions using Lattice Strategy

The lattice technique can also be used to multiply decimal fractions. For example, to multiply 5.8 by 2.13, the process is the same as to multiply 58 by 213 as described in the preceding section. To find the position of the decimal point in the final answer, one can draw a vertical line from the decimal point in 5.8, and a horizontal line from the decimal point in 2.13. The grid diagonal through the intersection of these two lines then determines the position of the decimal point in the result.

Statement of the Problem

The poor performance of Mathematics students in junior secondary school examination in Zaria metropolis is of great concern to teachers, parents, educationist and state ministry of education. Evidence shows that this condition is deplorably high to the point that Nigeria students start competing for the last position instead of first in mathematics examinations (Umar, 2019). Also there is evidence to lend support to the inappropriate teaching approaches in the subject. (WAEC, 2017). One wonders why all the methods used so far are not capable of reversing this ugly trend. It is however noted that the use of Lattice- Multiplication (LM) Strategy has not been tried out in Zaria metropolis, particularly in multiplication of two and multi-digit numbers to see if it could reverse or minimize this ugly trend. Therefore, the objective of this study is to provide evidence on the effect or otherwise of the use of Lattice – Multiplication (LM) Strategy on students' performance in multiplication of two and multi-digit numbers in Zaria metropolis Kaduna state, Nigeria.

Objective of the Study

The objectives of this study are:

1. To investigate whether the Lattice-Multiplication Strategy has effect on performance of junior secondary school students are taught multiplication of two and multi-digit numbers.
2. To verify whether the Lattice-Multiplication Strategy has an impact on gender performance among junior secondary school students taught multiplication of two and multi-digit numbers.

Research Questions

The following research questions were raised to guide the study:

1. What is the difference on mean performance of students taught multiplication of two and multi-digit numbers using Lattice-Multiplication Strategy and those that are expose to conventional method?

2. Will there be any difference on mean performance between male and female students taught multiplication of two and multi-digit numbers using Lattice-Multiplication Strategy?

Research Hypotheses

In line with the stated research questions, two null hypotheses were postulated for the study, they are;

H_o1: There is no significant difference on mean performance of students taught multiplication of two and multi-digit numbers using Lattice-Multiplication Strategy and those that are expose to conventional method.

H_o2: There is no significant difference on mean performance between male and female students taught multiplication of two and multi-digit numbers using Lattice-Multiplication Strategy.

Methodology

A quasi-experimental research design of pre-test, post-test nonrandomised control type was used in this research, the design is dependent upon natural setting in which the researcher find himself (Muhammed, 2017 and Tukman in Umar, 2019). This methodology was adopted because most of the school authorities do not allow researcher to carry out a random assignment of the subject to groups, as this will affect their school lesson and other activities. However, the intact classes were used for both experimental and control groups.

Population and Sample

The population of this study comprised of (1250) JSS3 students in (28) public junior secondary school students in Zaria metropolis. The choice of this population is because the concept of multiplication of two and multi-digit numbers is mostly taught in JSS2 and JSS3 levels. And the Sample for this research consist of (102) JSS3 students. Simple random sampling technique was used to sampled out of (1250) JSS 3 students from 28 public junior schools in Zaria metropolis Kaduna state, Nigeria. Out of 28 schools two schools were randomised and assigned experimental and control groups respectively. The Experimental group were exposed to LM Strategy while the Control group is exposed to conventional method of multiplication. The Table 1 below shows the summary of the sample for the study.

Table 1: Sample for the Study

Groups	Male	Female	Total
Experimental	34	28	52
Control	30	20	50
Total	64	48	102

(Researcher, 2020)

Instrument for the Data Collection

The instrument for data collection was multiplication concept performance test (MCPT). The MCPT items consist of 15 multiple choice questions. The instrument was validated and reliable index was found to be 0.79 using PPMC. Pre-test was given to both Experimental and Control groups i.e. group A and group B, to determine the level of their prior performance in multiplication before treatment. The multiplication of two and multi-digit numbers concept was taught using Lattice-Multiplication Strategy to group A, while standard algorithm method known as conventional method, was therefore, a post-test was administered after three weeks of treatment in first term 2019/2020 session. To determine the significant difference between the two groups as well as gender

difference i.e. male and female in the post- test result of the Experimental group.

Method of Data Analysis

The data collected were used to answer research questions using mean and standard deviation while null hypotheses were tested using inferential statistics i.e independent sample t-test analysis at (0.05). (Umar, 2019).

Results and Discussions

1. **Research Question one**: What is the difference on mean performance of students taught multiplication of two and multi-digit numbers using Lattice-Multiplication Strategy and those that are expose to conventional method?

Table 2: Mean and Standard Deviation for Performance between Group A and Group B.

Groups	N	Mean	Std-Div	M.D
A	**52**	**25.22**	**5.21**	**12.01**
B	**50**	**13.21**	**4,01**	

(Researcher, 2020)

It can be seen from the Table 2 that, Experimental group exposed to LM strategy has (M = 25.22, SD = 5.21, and MD = 12.01) while Control group has (M = 13.21, SD = 4.01). This indicates that the students exposed to LM Strategy performed higher than those exposed to conventional method.

2. **Research Question two**: Will there be any difference on mean performance between male and female students taught multiplication of two and multi-digit numbers using Lattice-Multiplication Strategy?

Table 3: Mean and Standard Deviation for Performance between Male and Female

Gender	N	Mean	Std-Div	M.D
Male	**34**	**22.32**	**3.21**	**1.21**
Female	**28**	**21.11**	**2.97**	

(Researcher, 2020)

Research Hypotheses HO_1: There is no significant difference between male and female on mean performance of students taught multiplication of two and multi-digit numbers using Lattice-Multiplication Strategy and those that are expose to conventional method.

Table 4: t-test Analysis for Performance between Experimental and Control groups

Group	N	X	SD	df	T	P
Experimental	52	25.22	5.21			
				100	14.602	0.003
Control	50	13.21	4,01			

(Researcher, 2020)

From Table 4, the result showed that p-value 0.003 is less than the alpha value of 0.05 level of significance at df 100. Since the p-value observed is less then alpha value it means the difference is significant. Therefore, the null hypothesis one which states that there is no significant difference in the performance of junior secondary school students taught multiplication of two and multi-digit numbers with Lattice-Multiplication Strategy and those that are exposed to conventional method is rejected.

Research Hypothesis $H0_2$: There is no significant difference on mean performance between male and female students taught multiplication of two and multi-digit numbers using Lattice-Multiplication Strategy.

Table 5: t-test analysis for post-test Performance between male and female students exposed to Lattice-Multiplication Strategy.

Gender	N	X	SD	df	T	P
Male	34	22.32	3.21			
				50	-0.997	0.322
Female	28	21.11	2.97			

(Researcher, 2020)

The result in **Table 5:** revealed that p- value (0.322) is greater than 0.05 level of significance for Experimental group which means that, there is no significant difference in the performance between male and female students taught multiplication of two and multi-digit numbers using Lattice-Multiplication Strategy. Therefore, the null hypothesis 2 is retained.

Discussions

Based on the findings of the study, it is clear that students who were taught using Lattice-Multiplication Strategy achieved higher result than their counterpart taught with conventional method of multiplication. Result of Table 4 showed significant difference between experimental and conventional groups. The result obtained indicated that JSS 3 students taught multiplication of two and multi-digit numbers using Lattice-Multiplication Strategy achieved significantly higher than there counterpart. The result agreed with the finding of Attah & Domyil (2015); Pilli (2013) and Nasiru &Binji, (2016) who discovered that students tend to performed better when they are taught new mathematics concepts using student-activity method oriented. Wenyuan (2001), discovered that students with learning disability were able to do multiplication by the conventional method with 15% accuracy, but they skilfully used the Lattice-Multiplication Strategy to multiply two and multi-digit numbers with more than 97% accuracy. The study also

determines the effect of gender performance of JSS 3 students when taught multiplication of two and multi-digit numbers using Lattice-Multiplication Strategy. The result shows that, both male and female students performed almost equally same, therefore, this strategy is gender friendly. This finding is in contradiction with Muhammed & Binji (2017) and Akinsola in Umar (2019) who state that male tend to perform higher than female counterpart when exposed to activity based method of teaching multiplication. The result also in agreement with Umar, (2019) which state that when students are exposed to practical approach, male and female students tend to performed equally in multiplication proficiency.

Conclusions

Based on the finding of this research we conclude that the Lattice-Multiplication Strategy can increase student's performance and bridge the gap between male and female student's performance if properly utilize.

Therefore, the use of Lattice-Multiplication Strategy is an important method for better achievement in learning and mastering of multiplication concept particularly in Zaria metropolis.

Recommendations

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

1. Ministry of Education and Secondary School Board in Kaduna State should organise workshops for the secondary school teachers on Lattice-Multiplication Strategy for effective teaching and learning of multiplication concept.
2. Professional bodies such as Science Teachers Association of Nigeria (STAN), Mathematical Association of Nigeria (MAN) among others, should organize workshops and seminars to popularize and sensitize mathematics teachers on the use of ethno-mathematics teaching materials as approach in teaching students the concepts of volumes of cylinders and hemispheres.
3. Teacher training institutions should include the use of ethno-mathematics teaching materials as method in the mathematics method course content. This will guarantee that after the training, teachers will be equipped on how to teach the concepts of volumes of cylinder and hemisphere effectively.
4. Further research is needed on this method to cover larger population in the state and Nigeria at large.

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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, Roektiningroem, 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

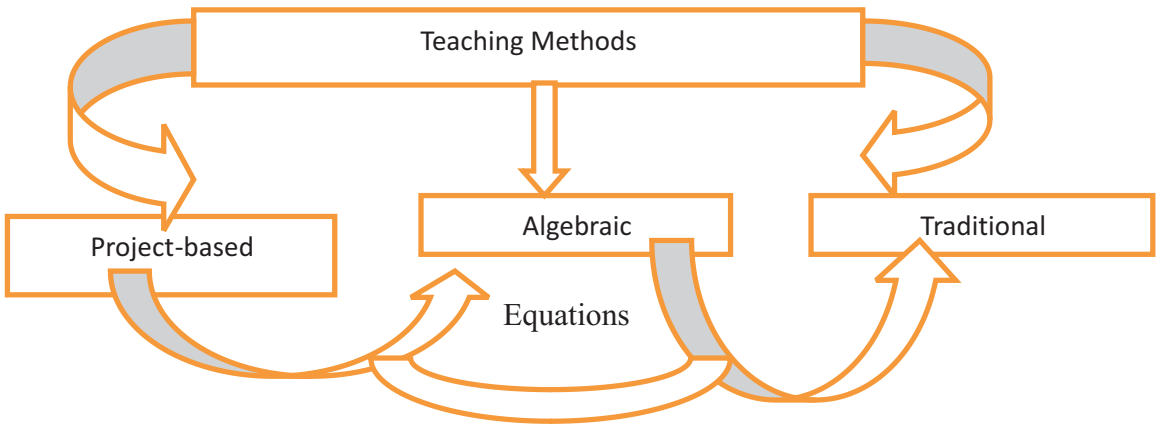

Figure 1: Diagrammatic representation of a conceptual framework for the paper

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

Ho_1: There is no significant difference in the mean performance of students taught Algebraic Equations using project-based and traditional methods

Ho_2: 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		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		**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 Ho_1:
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 A lgebraic 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_o Rejected
Traditional Method	175	8.17	2.08				

Source: Fieldwork (2021) **a-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 different exists between the two methods of teaching Algebraic Equations, i.e. project-based method and traditional method.

Null Hypothesis Ho_2:
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 RECIPROCAL PEER- TUTORING STRATEGY ON ACADEMIC PERFORMANCE AND MATHEMATICS TEST-ANXIETY IN GEOMETRY OF BOSSO LOCAL GOVERNMENT AREA STUDENTS

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Abstract

This study investigated the Effects of Reciprocal Peer-Tutoring Strategy on academic performance and mathematics anxiety-test in geometry among senior secondary school students in Bosso local government area, Niger State. The target population of this study consists of 4478 SS Two Students in public schools in Bosso Local Government Area, Niger State. The sample size read has 245 students (125 students assigned for control group, 120 students for experimental group). Two research questions were asked to guide the study and three null hypotheses were formulated at $P \leqslant 0.05$ level of significant. Two instruments were developed for data collections are: GPT and GTA and they are validated by experts. The reliability coefficient of GPT was estimated at r=0.65, while that of GTA stand as r=0.74, all are achieved through test-retest method. Two lesson models were designed for treatment for the groups; these are Reciprocal Peer-Tutoring Lesson Model (RPTLM) for Experimental group and Conventional Teaching Strategy Lesson Model (CTSLM) for control group. Firstly, the groups were tested by pre-test to measure their initial knowledge. Later the experimental group was exposed Reciprocal Peer Tutoring using the lesson model designed for that while control group was exposed to Conventional teaching strategy. Findings from the study revealed that the experimental group exposed to RPT performed better than the control group. It also revealed that the experimental group has little test-anxiety when compared to control group. It is against these findings, the following recommendations were made among others Mathematics teachers should be exposed to Reciprocal Peer-Tutoring through conferences, seminars, workshops and in-service training. Students should be encourage working in group, so that it will assists in understanding the subject matter, reducing anxiety, building trust and feel more at ease. Students should be encouraged to attend class lesson regularly; this will enhance familiarity with their peer as well enjoying mathematics especially geometry concepts.

Keywords: Reciprocal Peer-Tutoring, Conventional Teaching Strategy, Academic Performance, Mathematics Test-Anxiety, Geometry

Introduction

Mathematics is an indispensable tool for scientific and technological development for every nation. Mathematics played an important role in the development of society from pre-historic era to present. It is an academic subject in secondary school which one cannot afford to neglect because of its importance in all aspects of life. This led the federal government of Nigeria to make it one of the compulsory subjects and spelt out the objectives of teaching secondary school mathematics as to develop interest in mathematics and provide a solid foundation for everyday life. Also to develop computational skills, foster the desired ability of accuracy to a degree relevant to the problem at hand and develop necessary background for further education. Mathematics taught in secondary school curriculum in Nigeria was into seven major areas namely: Number and Numeration, Algebra, Menstruation, Geometry, Trigonometry, Statistics, and Probability.

Geometry is an area of mathematics which deals with the study of two or three dimensional shapes. Examples of two dimensional shapes which sometimes refer to plane shape are: triangle, rectangle, square, rhombus, circles and trapezium. Examples of three dimensional (solid shapes) are cubes, cuboids, cone, pyramid, cylinder and sphere. Geometry is a vital branch

in mathematics which forms the building blocks of engineering and technical graphics. It has been observed that student have not been demonstrating strong conceptual knowledge of the course. Many students in the secondary school level were not prepared for geometry courses (Hassan, 2010). Khadija (2018) reported that mathematics content in generally is perceived as difficult and unpleasant and learners often see it as stressful and anxiety-inducing burden. No doubt, there are evidences of discontentment in the performance of students in Mathematics at both junior and senior school certificate examinations. WAEC Chief Examiner (2016) that the conventional instruction is deficient in meeting the needs of majority of learners. The persistent use of the traditional method of instruction as one of the major shortcoming affecting performance and mathematics test-anxiety inducing burden especially geometry concepts. Hence, the present study, sought to examine whether teaching geometry concepts in mathematics via Reciprocal Peer-tutoring will enhance students' academic performance and reduce test-anxiety.

Reciprocal Peer Tutoring (RPT) is a collaborative technique of instruction where students of the same class and age bracket alternate between the role of students (tutees) and teachers (tutors). RPT strategy allows each of the students the chance to teach a review lesson, monitor other students in the group, and also evaluate each other work through observations or work samples. RPT increases academic performance and while simultaneously decreasing disruptive behavior.

The technique improves both grades scores behaviors through the group setting and also promotes social competence, social skills awareness, and peer acceptance (Ginga, Mohammed & Usman 2019).Teaching mathematics especially geometry is quite different from teaching other subjects in secondary school. The mathematics classroom is different from other classrooms in humanities, such as English, History, Government, etc, the quality of teaching mathematics is mainly depend on the competency of mathematics teacher as well as the teaching method use by the teacher to teach the students. RPT helps the teacher to activate students'curosity about a topic and assists in developing critical thinking and mathematical skills among students. According to Francisco,at.el (2018)and John (2016) that RPT is good strategy that have potent to improve cognition of student because it facilitate learning and reduce mathematics test-anxiety.

Test-anxiety is a term used for several disorders that cause nervousness, fear and apprehension and worrying. It is also seen as a cognitive behaviors rising from self-doubt and self-depreciation. Jerry, Desmond and Rose, (2019) stressed that Mathematics test-anxiety affect student confidence in mathematics and that many students who suffer from mathematics test anxiety have little confidence in their ability to do any mathematical problem and brings poor performance in the subject especially geometry. Mathematics test anxiety involves a feeling of tension and apprehension about performing mathematics and is associated with delayed acquisition of core mathematics which leads to poor mathematics competence. It can be view as a situation of discomfort observed during working on mathematics problems as reported by (Ahmad & Auwal, 2021). They described mathematics test anxiety as the panic helplessness, paralysis and mental disorganization that arises among some people when they are required to solve mathematics problem. According to Ahmad and Baba (2021) that many learners experience some degree of stress and anxiety before and during exams, test anxiety can actually impair learning and hurt test performance. He further stressed that a little nervousness can actually help you perform your best but when this distress becomes so excessive that is actually interferes with performance in an examination, it then refers as test-anxiety. However, Reciprocal Peer-tutoring has a lot to do to reduce level of mathematics test-anxiety. Since tackling difficult concepts group learning may provide a source of support. Group often use humor and create a more relaxed learning

atmosphere that allow for positive learning experiences. The strategy is especially beneficial in inclusive classrooms because groups can address a wide range of learning needs and disabilities. It founded in the strategy that cooperative and active learning decreases students' mathematics-anxiety and as a result, positively impacts their performance in mathematics. As long as they stay on task, the present study was conducted to examine the effects of reciprocal peer-tutoring on test-anxiety and performance in geometry concepts among senior secondary school students.

Steps in the of Reciprocal Peer-Tutoring

Four steps involves in the use of RPT (predicting, clarifying, solving and summarizing), which is modified by Ginga, Mohammed and Usman (2019) and adopted in this study.

Step 1: Grouping of four

Step II: Distributing each member of the group with unique role, ie; predictor, clarifier, solver and summarizer

Step III: At this point, the predictor will play its role by predicting the type of mathematics questions and what type of mathematical operations that is required.

Step IV: The clarifier will play its roles by clearing unfamiliar words and states all mathematical facts in a given problem.

Step V: The summarizer is then required to justify the solutions and evaluate how they would refine the process if presented with similar problem.

Step VI: The role of each member would be exchange, so that all the participant in all the four strategies.

Step VII: Through the process the teacher's role is to guide them and also see that every student's ability uses the strategies

Reciprocal Peer-Tutoring provides teachers with more time to work on upcoming lesson plans. As for students, they benefit from receiving more one-on- one instruction and engaging in active learning. Students are also able to track their own progress, gives them more accountability over their task.

Statement of the Problem

The teaching of mathematics has been a subject of consideration in secondary school education in Nigeria but students continue to record mass failure in Mathematics especially Geometry as reported by Chief examiner (2016, 2018 & 2019).It has been reported that among prominent problems which have attributed consistence poor achievements of students in Senior School Certificate Examination (SSCE) are:

- Inadequate of qualified professional mathematics teachers:
- Parental negative comment about mathematics;
- Unprepared for teaching of mathematics by mathematics teachers;
- Adherence to conventional teaching method in spite of exposure to more viable alternative and
- Students negative attitude towards mathematics.

The identified problems do not create conductive environment for teaching and learning of mathematics and all these have made mathematics especially geometry teaching and learning in a deplorable state of affairs in all levels of educational system in Nigeria. Most students cannot comprehend geometry expressions coupled with their high level of mathematics test anxiety towards mathematics in general, which causes tremendous consequences on their understanding and performance. Therefore, it has become necessary to search for a teaching method which is capable of improving the students' performance and reducing mathematics test-anxiety. Based on this, the present study suggest to investigate what will be the effects of reciprocal peer-tutoring on mathematics test-anxiety and academic performance in geometry among secondary school students in Bosso Local Government Area, Niger State

Objectives of the Study

The study was designed to investigate the effect of Reciprocal Peer-Tutoring on Academic Performance and Mathematics test-anxiety in

Geometry among Secondary School Students. The study has the following objectives to:

1. Assess whether students who were taught geometry using Reciprocal Peer-Tutoring perform better than those taught using Conventional Teaching Strategy.
2. Determine whether students who were taught geometry using Reciprocal Peer-Tutoring will reduce level of test-anxiety than those who are taught using Conventional Teaching Strategy.

Research Questions

This study was guided the following research questions:

1. What is the effect of Reciprocal Peer-Tutoring and Conventional Teaching Strategy on the performance of students taught geometry concepts of senior secondary schools?
2. Does Reciprocal Peer-Tutoring and Conventional Teaching Strategy influence level of mathematics test-anxiety of senior secondary students?

Null Hypotheses

The following null hypotheses are formulated to be tested at $P \leqslant 0.05$ level of significance.

Ho_1: There is no significant difference between the pre-test scores of students taught geometry concept using Reciprocal Peer-Tutoring and Conventional Teaching Strategy.

Ho_2: There is no significant difference between the mean performance scores of students taught geometry concept using Reciprocal Peer-Tutoring and Conventional Teaching Strategy.

Ho_3: There is no significant difference in the level of test-anxiety of students taught geometry using Reciprocal Peer-Tutoring and Conventional Teaching Strategy.

Research Methodology

The research design employed for this study was quasi-experimental design. The study has two groups: control group and experimental group. The control group was exposed to conventional teaching strategy while experimental group was exposed to reciprocal peer tutoring. Intact classes were used so as to avoid disrupting the school programmed. The target population of this study was public schools under Niger State Ministry of Education, made up of 4478 students (2430 Males, 2048 Females) of SS Two class in Bosso local area of Niger State. The state public schools were considered, mainly due to their common socio-economic status, admission policy and staffing.

Multi-stage random sampling was adopted. In the first stage, the schools were group and selected based on location using cluster techniques. In the second stage, two schools were selected from each cluster, which one school is assigned as control group and other one as experimental group using simple random sampling. In the three stages, one intact class was selected from each school selected. The sample size of the study consists of 125 students in the control group and120 students in the experimental group.

Two instruments were used for data collection. These are Geometry Performance Test (GPT) and Geometry Test-anxiety (GTA). The GPT consists of twenty objective questions generated from Senior Secondary School Certificate Examination (SSCE) and National Examination Council (NECO) with options A-E. The GPT is to served as Pre-test to measure students' initial knowledge and homogeneity in geometry. Later the GPT was reshuffled to serve as Post-test to measure students' performance in geometry after treatment of the groups.

The initial GPT was thirty objectives questions but was reduced to twenty items in the process of face validation by two experts from IBB University Lappai and item analysis to determine its difficulty and discrimination power of each item. The test-retest method of reliability coefficient was employed and PPMC at $r = 0.65$.

Geometry Test-Anxiety (GTA) questionnaire developed by Ahmad and Auwal (2021)

modified and adapted on five points scale. The model consists of ten statements and after each statement, the numbers 1,2,3,4 and 5 are used to rate your personal feelings. Personal feelings are rating as 5 for extremely highly or always true, 4 for highly or usually true, 3 for moderately or sometimes true, 2 for slightly or seldom true and 1 for not all or never true. The GTA has reliability coefficient of 0.74.

Two lesson models was designed for treatment of the groups, these are Reciprocal Peer-Tutoring Lesson Model (RPTLM) for Experimental group and Conventional Teaching Strategy Lesson Model (CTSLM) for control group. Firstly, the groups were tested by pre-test to measure their initial knowledge. Later the experimental group was exposed Reciprocal Peer Tutoring using the lesson model designed for that while control group was exposed to conventional Teaching Strategy, which lasted five weeks.

Table 1: t-test Analysis of Control and Experimental Group in Pre-test

Groups	N	Mean	S.D	DF	T- cal	P-value	Remark
Control.	125	46.70	16.65				
				243	-0.60	.55	Not Sig
Experimental	120	47.93	16.32				

From the result presented in Table 1 shows that there was no significant difference in the control group and experimental group as recorded by p-value greater than $\alpha = 0.05$ level of significance in the comparison of the mean scores in the pre-test. It can also be concluded that the groups are equivalent and hence null hypothesis one which say no significant difference was retained.

Research Question One: What is the effect of Reciprocal Peer-Tutoring and Conventional Teaching Strategy on the performance of students taught geometry concepts of senior secondary schools?

Table 2: Means and Standard Deviation of Experimental and Control Group in Post test

Group	**N**	**Mean**	**SD**	**Mean Difference**
Exp.gp	125	63.42	15.75	
Control gp	120	36.26	16.55	27.16

Result in Table 2 indicated that mean scores of experimental group was 63.42 with standard deviation 15.75 and Control group was 36.26 with standard deviation 16.55 The large mean difference 27.16 was recorded in favor of experimental group which shown that treatment has an effect on the group.

Research Question Two: Does Reciprocal Peer-Tutoring and Conventional Teaching Strategy influence level of mathematics test-anxiety of senior secondary students?

Table 3: Means and Standard Deviation of Experimental and Control Group in GTA

Group	**N**	**Mean**	**SD**	**Mean Difference**
Exp.gp	125	63.74	16.51	
Control gp	120	46.70	16.65	17.04

Result in Table 3 showed that mean scores of experimental group was 63.74 with standard deviation 16.51 and control group has mean scores 46.70 with standard deviation 16.65. The mean difference 17.04 was recorded in favor of experimental group, which indicated that the treatment has reduced the anxiety level in the group mean scores.

Null Hypothesis Two: There is no significance difference between the mean performance scores of students taught geometry concept using Reciprocal Peer- Tutoring and those taught using Conventional Teaching Strategy.

To test whether there is significance difference in the mean scores of the groups, a t-test analysis was carried out and Table 4 presented the results.

Table 4: t-test Analysis of Control and Experimental Group in Post-test

Groups	N	Mean	S.D	DF	T- cal	P-value	Remark
Exp.gp	125	63.42	15.75				
				243	15.56	.00	Sig
Control gp	120	32.26	16.55				

To evaluate the effectiveness of the instructions, a post-test was administered to both groups at the end of the treatment. The data in Table 4 indicates that $\alpha = 0.05$ level of significance is greater than P-value (.000) at DF= 243, the null hypothesis was therefore rejected. It was concluded that there is significant difference in the performance scores of the two groups in geometry concepts.

To test whether there is significant difference in the level of test-anxiety of the two groups; a t- test was used. Details are as follows in Table 5

Table 5: t-test Analysis of Experimental Group and Control Group in Geometry Test-anxiety scores

Groups	N	Mean	S.D	DF	T- cal	P-value	Remark
Control	125	46.70	16.65				
				243	- 8.28	.00	Sig
Experiment	120	63.74	16.51				

Results Table 5 shows that $\alpha = 0.05$ level of significance >P-value= .00, this indicates that there was significance difference in the level of test-anxiety of two groups, thus, the null hypothesis was rejected.

Discussions

The findings of this study in relationships between research questions and null hypotheses are presented. The result from statistical analysis of hypothesis one as shown in Table 1 revealed that the two groups are equivalent in performance at the beginning of the experiment. The result in Table 2 indicated that the experimental group exposed to RPT performs better than those exposed to CTS. This finding confirmed the submission made by Ginga, Mohammed and Usman(2019) that the strategy increases academic performance among the peers because it allows each of learners the chance to teach a review lesson, monitor others and evaluate each other work through observations and collaborative studies. It was also supported by the findings of Fransco,et.al (2018)and John (2016) that RPT is good strategy that have potent to improve cognition of student because it facilitate learning and reduce mathematics test-anxiety through social interaction that involves in the strategy. Students in the experimental group spend more time in the

learning process and there is a direct interaction in which the student is open and feels comfortable which foster active learning. Actually the RPT strategy improves the cognitive again and social gain as well.

The result from Table 3, which revealed that the experimental group that are exposed to Reciprocal Peer-Tutoring has little test-anxiety compared to control group. This finding is in agreement with findings of John (2016) and Jerry, Desmond & Rose, (2019) that there is significant relationship between mathematics test-anxiety and performance in mathematics. They stressed that if nervousness is little it assists in performing better but when it is excessive it interferes with performance in any exams. Students exposed to RPT may feel more at ease when they deal with peer tutor rather their teacher which enhances them to study better and concentrate more on the learning task which reduce their anxiety and allow for better understanding of the concepts as reported by (Ahmad & Baba, 2021).

Conclusion

The conclusion of this study is made through the results obtained and that those students exposed to RPT perform better than those in the CTS. And also those students in experimental group have little test- anxiety compared to those in control group. Therefore, the reciprocal peer tutoring enhancing effective teaching-learning of mathematics particularly geometry concept and reduce mathematics test anxiety in students.

Recommendations

The current study shows that Reciprocal Peer Tutoring is an active tool in improving academic performance and mathematics anxiety test in geometry at secondary school level. It is against this background, the followings are strongly recommended;

1. Mathematics teachers should be exposed to Reciprocal Peer-Tutoring through conferences, seminars, workshops and in-service training.
2. Students should be encourage working in group, so that it will assists in understanding the subject matter, reducing anxiety, building trust and feel more at ease
3. Students should be encouraged to attend class lesson regularly, this will enhance familiarity with their peer as well enjoying mathematics.

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TEACHING FOR MATHEMATICS SENSE: A TOOL FOR FIGHTING EMERGING DISEASES AS COVID-19.

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Abstract

The study used a qualitative research design to explain the critical role Mathematics plays in the fight against COVID-19. This is because many individuals hardly notice where the subject is applied in life especially during pandemic. The world was in a state of confusion when Corona Virus striked with its devastating effects on human life. Many people assumed that the end has come, and some of them were busy apportioning blames. Some experts (i.e. doctors, pharmacy, chemists, tailors, and teachers) worked hard to combat the dreaded virus. All measures by experts relate to Mathematics. The subject is made compulsory and taught at the primary and secondary school levels to enable learners acquire its knowledge for application in life. COVID-19, though a pandemic, presents a situation that the knowledge of the subject is useful for preventive measures to production and administration of vaccines. For instance, the subject is very useful in terms of maintaining social distance/physical distance, washing of hands at intervals of 10 minutes, maintaining airspace, face masks design, restriction at home within a perimeter, explaining waves of the disease, and administration of the vaccine. In view of the relevance of the subject, Mathematics teachers should effectively teach the subject especially at the primary and secondary school levels to enable learners apply its knowledge during pandemic. Government/proprietor should ensure employment of qualified teachers for effective teaching of Mathematics.

Keywords: Teaching, Mathematics, COVID-19

Introduction

Instruction has been a means of creating awareness among living things especially humans from time immemorial. In the absence of instruction, the human mind could remain unenlightened. Instruction can take the form of teaching different concepts to learners. According to Bello (2017), teaching has been one of the oldest and respectable profession in the world. The teacher is the initiator of the learning process, the assessor of the learning efficiency and indeed the pivotal element in the entire educational development (Iyekekepolar & Alexander, 2014). The teacher is a critical factor in the teaching and learning processes. The teacher guides the learner in the course of learning concepts and procedures during lesson. Skills that Mathematics teachers possess and those that the acquire through training enable them to impart knowledge of concepts and procedures of the subject to learners, as they deal with the abstract and unique nature of the subject (Odogwu & Lawal, 2016). Teachers can effectively teach Mathematics through training as effectiveness is a function of their acquisition of the requisite knowledge and skills (Okeke, 2016). Also, how teachers teach, behave, and interact with students can be more paramount than what they teach (Lawal & Yelposu, 2014). Besides, Mathematics teachers who carefully plan their lessons and control their emotions before instructing learners would be effective in teaching the subject. Therefore, Mathematics teachers' training, disposition to learners, careful tracking of lesson plan and emotions for instruction make their lessons understandable to learners.

According to Republic of South Africa (2018), teaching Mathematics for understanding means teachers should strive to:

1. teach Mathematics for conceptual understanding to enable comprehension of mathematical concepts, operations, and relations;
2. teach so that learners should develop procedural fluency which involves

skills in carrying out procedure flexibly, accurately, efficiently, and appropriately;

3. develop learners' strategic competency-the ability to formulate, represent, and decide an appropriate strategy to solve mathematical problem;
4. provide multiple and varied opportunities for learners to develop their mathematical reasoning skills-the capacity for logical thought, reflection, exploration and justification; and
5. promote a learner-centred classroom which enables all of the above, supported by teachers engaging with leaners in ways that fore ground mathematical learning for all.

The subject is taught by teachers at different levels of education because it plays a critical role in politics, entrepreneurship, bioterrorist, security, technology, governance and healthcare delivery (Odebode, 2015: Guwam, 2015; Okwuoza & Azuka, 2015). According to Idris (2013), the onus lies on Mathematics teachers to show that the subject is for real world and not a bunch of useless and boring nonsense as some learners would otherwise perceive it. Mathematical topics like mensuration, statistics, arithmetical progression, plane geometry, ratio, rate, percentage, locus, and graph are applied at different stages in the prevention, treatment, and vaccination of COVID-19 pandemic. Concepts of these topics are used in maintaining social distance, maintaining airspace, restriction at home, face mask design, explaining wave of the disease, and administration of the vaccine. In maintaining social distance, one must apply the concept of straight distance between two points, and a grasp of units of measuring distance like millimetre, centimetre and metre is important . Maintaining of airspace requires the knowledge of mensuration and locus. One has to understand the concepts of area and volume, as well as locus of a point equidistant from given point (a circle). On washing of hands, knowledge of statistics and arithmetic progression are necessary. The number of times (nth term) of washing hands in interval of 10 minutes is arithmetic progression. The distribution table for minutes and number of times hands are washed is statistical. Restriction at home refer to the knowledge of area and perimeter of plane shapes to reduce the spread of the virus. Those face shields are design in the form of plane shapes. Most of them look like triangles, rectangles, parallelogram, rhombus, and semicircle, or a combination of two plane shapes. Wave of the disease is explained using statistics and graphs. Tally, frequency, ratio, rate, percentage, and graph are applied in informing the public on the wave of the disease. Vaccines of the virus are developed. Statistics are used in reading the millilitres of the vaccine for administration, interval of administration of the vaccine, and number of people vaccinated, as ratio, rate, and percentages are used in expressing the success rate of the vaccine. Thus, Mathematics plays an indirect but effective role in the fight against COVID-19.

Many individuals hardly see where Mathematics is useful in life. They think the essence of teaching the subject especially at the secondary school level is to obtain a pass or a credit for admission into tertiary institutions. Yet the subject is applied to save life particularly during COVID-19 pandemic. The world was in a state of confusion when Corona Virus striked. Many people assumed that the end has come and some of them were busy apportioning blames, a good number of experts (i.e. doctors, pharmacy, chemists, tailors, and teachers) worked hard to combat the dreaded virus. The fight against COVID-19 require mental Mathematics. According to Sinay and Nahornick (2016), "mental math skills are important and are often use in commerce, work and everyday activities, yet many learners are calculator dependent" (p.18). Unfortunately, learners often think that Mathematics is black and white, with right and wrong answers, and questions that can be solved in 1 to 2 steps (Sinay & Nahornick, 2016). The society has reduced Mathematics to mere means

of gaining admission into tertiary institution, and so the struggle at all cost to get a credit pass in the subject as a ticket for gaining admission is the order of the day especially in Nigeria. However, the Mathematics teacher needs to teach the subject in such a way that learners will understand concepts taught, and make use of mathematical sense in life. According to Ogbonnaya and Charles-Ogan (2015), "teaching entails the application of skills and carry out of appropriate activities that enable learners to develop and ultimately exhibit expected learning behaviour" (p.531). Thus, if humans understand Mathematical concepts, their application to avoid huge loss of life and property during pandemic as COVID-19 would not be a difficult task.

MEASURES OF COMBATING COVID-19

Maintaining Social Distance

The ravaging scourge of COVID-19 made the use of Mathematics skills essential. One requires the knowledge of straight distance between two points, as well as understanding of units of measuring distance like millimetres, centimetres and metres and their relationships. These will help one to approximate mentally at every moment distance of 15 metres between one's point and another to avoid the risk of contracting COVID-19. This reduce exposure to social situations of contracting the virus and is critical in maintaining of social anxiety (Arad, Shamai-Leshem & Bar-Halm, 2021). Some people claimed that there is no need for social distance, but physical distance is very important in halting the spread of the deadly virus. The first question is: What is physical distance of at least 15 metres? Geometrically, it simply means maintaining a radius > 15 metres between one person and another. The next question is: How could one that does not like Mathematics or figures be able to mind every moment a distance of at least 15 metres? These questions show that one has to learn and understand Mathematics. On physical distance, at any point one has to remain in the centre of an area of > 707.14 metres square, to avoid the risk of infection.

$A = \pi r^2$, where A = Area, $\pi = \frac{22}{7}$, r= radius

$= \frac{22}{7} \times 15^2$

$= \frac{22 \times 225}{7}$

$> 707.14 m^2$

Maintaining Airspace/Volume

The blanket of air that surrounds the Earth is about 200 kilometres. Humans survive out of this area with oxygen. Within this area, clean air or uncontaminated air is required for the prevention of COVID-19 (European Centre for Disease Prevention and Control, 2020). This requires the knowledge of mensuration which deals with volume. It also requires the knowledge of locus of a point equidistant from given points (a circle). Those on seat, in bus or flight, on bicycle or foot should maintain a physical distance of at least 15 metres. The physical distance of at least 15 metres between one person and another creates an opportunity for one to breath within a volume of air > 14142.85714 metres cube. This implies that one should remain within an air volume greater than or equal to 14142.85714 metres cube in a fixed position or in motion, relative to one's nose. This is to avoid the contamination of air by the COVID-19.

$V = \frac{4\pi r^3}{3}$, where V= Volume of air, $\pi = \frac{22}{7}$, r= radius

$= \frac{4 \times 22 \times 15^3}{3 \times 7}$

$> \frac{297000}{21}$

> 14142.85714 metres cube

Washing of Hands

Washing of legs and hands when one comes from market, place of worship or any gathering have been part of most cultures in Africa. But washing of hands has become a culture of the world in the instance of COVID-19. One is expected to wash hands before starting work, frequently during work, after contact with secretion, after contact with potential contamination objects (glove, clothing, mask, use tissues, waste) and immediately removing gloves (Cirrincione, Plescia, Ledda, Raspisarda, Martorana, Moldovan, Theodoridou & Cannizaro, 2020). Washing of hands require the knowledge of arithmetic progression to show the nth term for washing of hands in intervals of 10 minutes as 10n, and statistics to display distribution table for minutes and number of times hands are washed. Washing of hands every 10 minutes means that in one hour hands must be washed 6 times. In 8 hours, hands must be washed 48 times, and so on. The entire process is arithmetically progressive.

The table below shows the time in multiples of 10 and number of times to wash hands.

Time (Minutes)	10	20	30	40	...
Times (washing of hands)	1	2	3	4	…

The nth term for the number of times to wash hands

T_{nth}= a + (n-1) d, where a = The first term (10 minutes), n = any term, d = difference between two consecutive minutes.

= 10 + (n-1) 10

= 10 + 10n-10

= 10n

Restriction at Home

Restriction at home or lockdown is one of the best options. It means one should remain in a compound or house. Geometrically, it implies one must be in an area within a perimeter. This could be within one's room or fence. This relate to concepts of area and perimeter of plane shapes in plane geometry. Though researches are ongoing on the development of vaccines, medical personnel focus on the treatment of the symptoms through administration of drugs at regular intervals. Those people that exhibit symptoms are quarantine for two weeks, a period minimum for the manifestation of symptoms of the disease (Guner, Hasanoglu, & Aktas, 2020). Adhering to those intervals determine the speedy recovery of an infected person. The test is done within an interval before one is certified as free from the virus or not. Those intervals of quarantine, administration of drug or vaccine are defined by mathematical indices.

Face Mask or Face Shield

Face masks/Face shields are geometrically inclined. They are the application of plane shapes as triangles, rectangles, parallelogram, rhombus, or semicircle. Face mask is produced as preventive measure against the dreaded COVID-19. The face mask in the form of rectangle with strings to be attached to the ears is used to cover the mouth and nose. The World Health Organisation (2020) suggested the use of masks as part of comprehensive package of prevention and control measures to limit the spread of COVID-19.

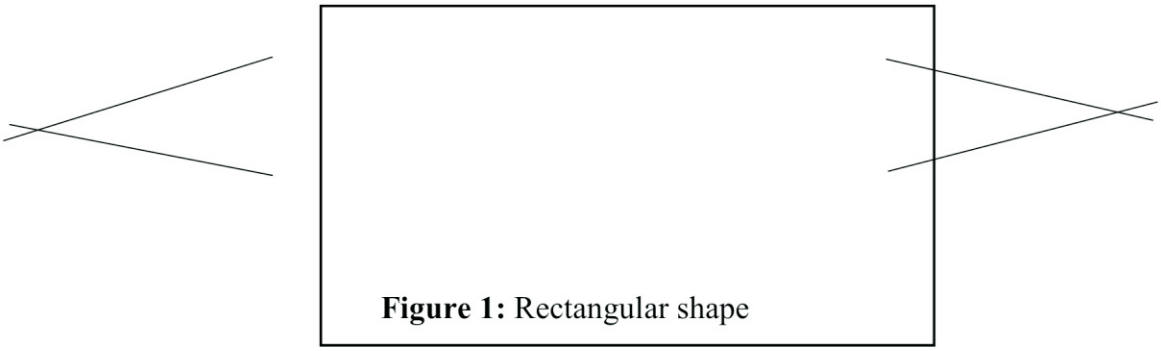

Figure 1: Rectangular shape

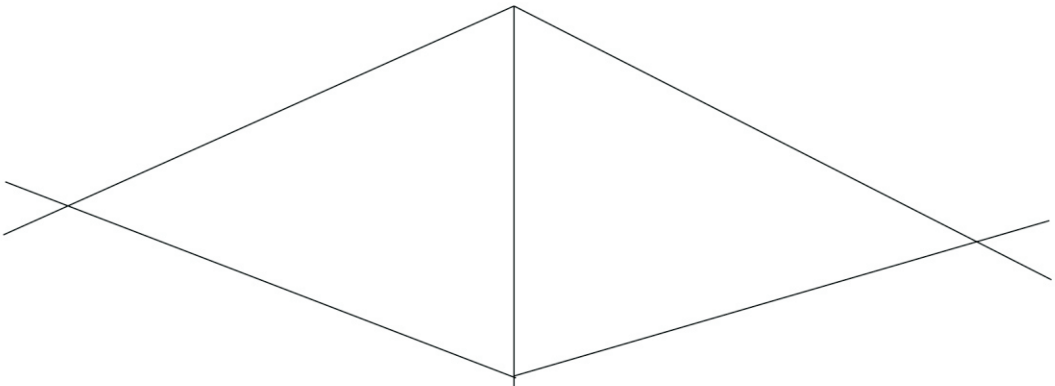

Figure 2: Triangular

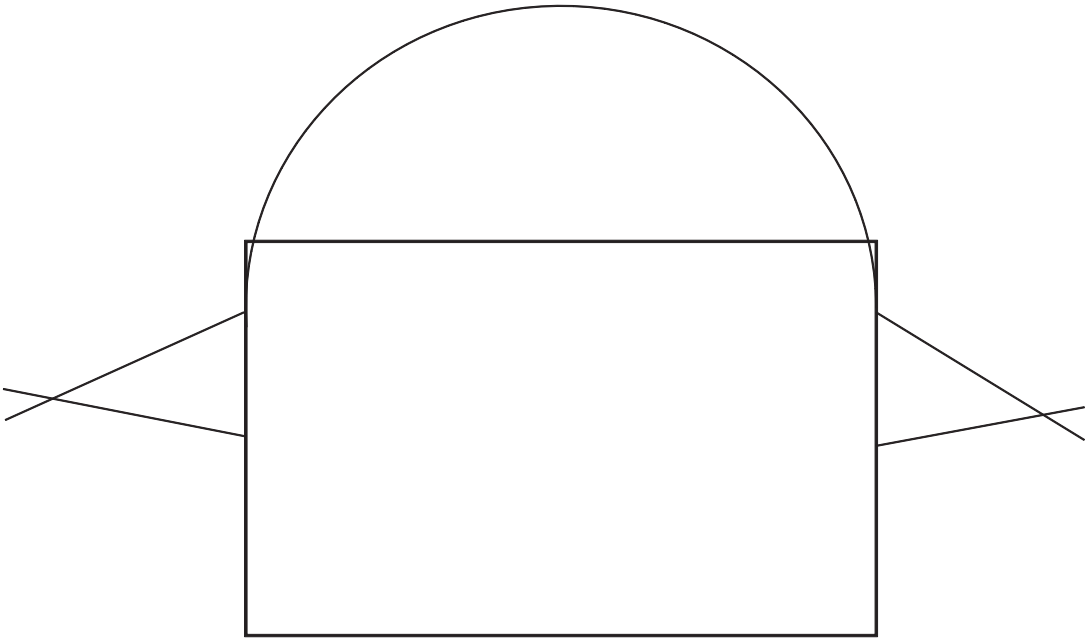

Figure 3: Rectangular and Hemispherical

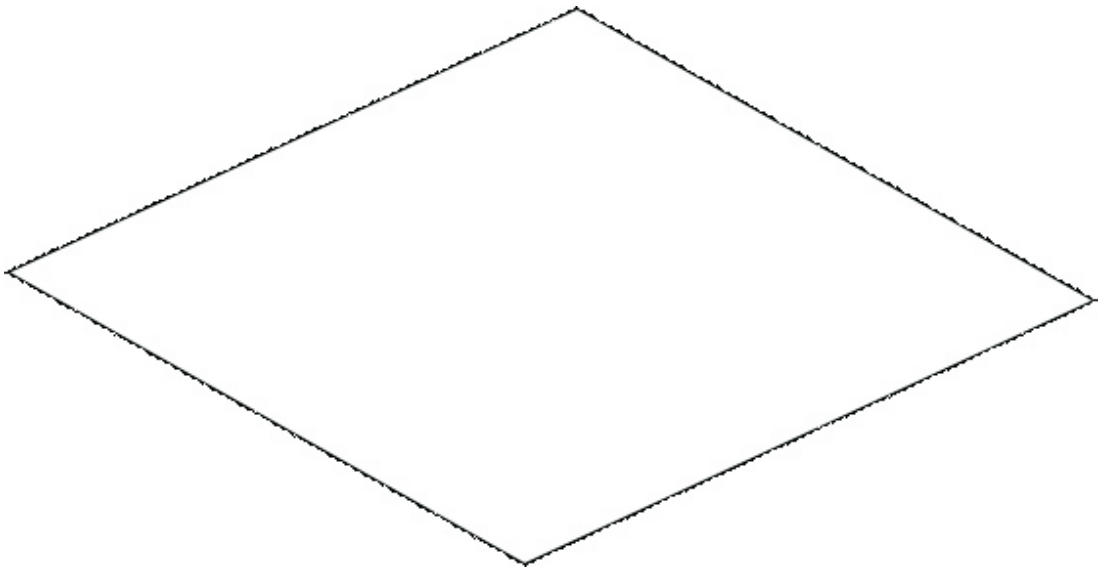

Figure 4: Parallelogram

Waves of the Disease

Data collected over a period of time, across a particular group in terms of age, the rate of spread of the virus among children, middle age and aged groups define the wave of COVID-19. Data collected also give rise to the statistics showing the wave of the virus, whether first, second, third, etc. waves. The rate of death per day determine which wave is dangerous (Dat, Frederic, Hang, Jules, Thang, Piffault, Willy, Susely, Le, Tuschmann & Zung, 2020). Tally, frequency table, and percentage are used to prepare records for informing the public on the virus. Also, the data collected on the virus are presented using graphs for clarity and easy interpretation.

Vaccines of the Virus

A vaccine is administered to prevent one from sudden death when infected with COVID-19. The knowledge of statistics is used, for instance, in indicating the millilitres of the vaccine to be administered, interval of administering the vaccine, and the number of people vaccinated. The vaccine is developed for different age groups; teenager, middle age and aged groups. Before a vaccine is certified, it must undergo processes. The first is trial on animals, followed by administration on small and large groups of humans across regions of the world. Ratio, rate and percentage are used to present information on the resistance to the virus, success rate of the virus, and strain of the virus that is dangerous. Also adequate data taken from dosage administration, needle and syringe, temperature level requirement for preservation of vaccines for transportation among others involved mathematical statistics. The vaccination processes can be modelled using ordinary differential equation (Gonzalez-Paira, 2021). Thus, Mathematics plays a vital role in the entire process of developing a vaccine for humans.

Conclusion

As long as humans live on earth, there will be diseases and even epidemics that have the potential to ravage the human race. This means that humans' interaction with the natural environment make them vulnerable to infection by organism or micro-organism that can hardly be seen with the naked eyes. The human mind needs to be enlightened on steps or measures of combating disease such as COVID-19 in order to avoid the colossal loss in economy, human life and brains that would take a generation to regain. It is often said that knowledge is power. The knowledge of Mathematics topics like mensuration, locus, arithmetic progression,

plane shapes, statistics, and percentage are critical when observing social distance, airspace, interval for washing hands, restriction at home, face masks, wave of disease, interval for taking drugs and measures for developing a vaccine. Therefore, there is need to emphasise the effective teaching of Mathematics for understanding of its concepts toward application in life.

Recommendations

1. Mathematics teachers should effectively teach the subject for better understanding of its concepts for taking safety measures against diseases such as COVID-19.
2. Parents/Guardians should encourage their wards to develop interest in Mathematics in view of its relevance in combating emerging disease such as COVID-19.
3. Government/proprietors should employ qualified teachers that would teach Mathematics in our schools for understanding apart from provision of instructional materials.

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AN INVESTIGATION INTO THE IMPACT OF JAPANESE MULTIPLICATION PEDAGOGICAL APPROACH ON SECONDARY SCHOOL STUDENTS' INTEREST AND PERFORMANCE IN QUADRATIC EXPANSION IN MAKURDI METROPOLIS

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Abstract

The study focused on investigation into the impact of Japanese multiplication pedagogical approach on secondary school students' interest and performance in quadratic expansion in Makurdi Metropolis. The study used a quasi-experimental design. A sample of 15 students was used for the purpose of the study. The experimental group were expose to the Japanese Multiplication Pedagogical Approach (JMPA) while the control group were taught using the traditional approach. The instrument used for data collection were Expansion Performance Test (EPT) with a reliability coefficient of 0.81 using the Kuder Richardson Formula 20 and Mathematics Interest Inventory (MII) with a reliability coefficient of 0.75 using Cronbach Alpha. Four research questions and four research hypotheses were raised for the study. The research questions were answered using the descriptive statistics of mean and standard deviation while the Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Result from the study revealed that the students that were taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those that were taught using the traditional approach had the same level of performance, however, those in the JMPA demonstrated a higher level of interest in learning mathematics. The study also revealed that there is no significant difference in the mean performance score and interest rating of male and female students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach. The study recommends that teachers should implement strategies that build a student's interest in learning mathematics as student's interest in a topic carry so much ability.

Keywords: Japanese Multiplication, Quadratic Expansion, Students' Interest and Performance

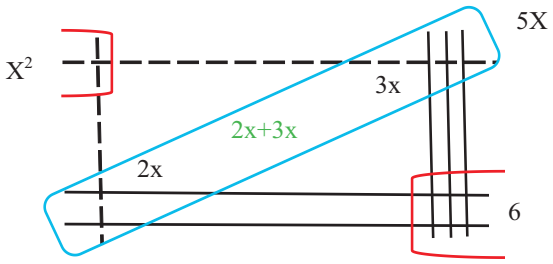
Introduction

Mathematics first start from the mind; how ready and how positioned the mind is to assimilate mathematical concepts. In the learning of any concept in Mathematics, the mind of the learner must have been familiar with some related attributes of the concept which are in connection to real life situations. Over the years, mathematics has been mistaken by many to be a totally abstract, difficult, unimportant and one that lacks connection to real life situations. However, mathematics is a fundamental part of human thought and logic, and integral to attempt at understanding the world around us. Mathematics provides an effective way of building mental discipline and encourages logical reasoning and mental rigor (Kyungmee, Aarnout, Joana & Lynn, 2008). Mathematics has become the companion of man and his helper since the beginning of human existence on earth. When man first wanted to answer questions such as "How many?" he invented mathematics (Harrison, 2018). Thus, mathematics is the pillar of organized life for the present day. Without mathematical evidence, resolving of issues in our daily lives will be impossible. Mathematics is a study of measurement, numbers and space which is one of the first sciences that humans work to develop, because of its great importance and benefits. It is a vital tool that helps to develop the ability to think, develop wisdom, increases the speed of intuition, and it also helps to explain how things work (Harrison, 2018). The importance of mathematics to our daily lives is one that cannot be over-flogged. The advancement in architectural, technological, and business world are all at the mercy of mathematical knowledge and input. Mathematics is one of the key subjects offered in primary and secondary schools and even studied at the higher institutions. Arithmetic, geometry, calculus, algebra are the branches of mathematics.

Algebra is one of the various branches of mathematics. It deals with symbols and variables. Algebra includes several forms of mathematical representations, such as real numbers, complex numbers, vectors, matrices

and so on. Quadratic expression are algebraic expressions where the highest exponent of the independent variable is 2. Expansion of quadratic expression simply means removing the parentheses or brackets from an expression. This is done by multiplying each component of one bracket by the other bracket. For an expression of the form (a + b) (c + d), the expanded version is a(c+d)+b(c+d)=ac+ad+bc+bd.Quadratic expressions are expanded usually using the FOIL (First, Outside, Inside, Last) method and also the Punnet square method. Alternatively, the Japanese method of multiplication has been considered as an interesting and fascinating method for quadratic expansion.

The Japanese method of multiplication works the same way the place value multiplication algorithm works, except that each digit is represented in unary. The Japanese multiplication method is an algorithm for multiplying two large numbers by representing both numbers by a group of lines that form a diagonal pattern. The number of points of intersection near each vertex of a diamond are then counted in a certain order to obtain the solution (Vreken, 2017; Garain & Kumar, 2018). In the Japanese multiplication method, a student can complete a multiplication problem of two large numbers by merely drawing a few lines and counting the points of intersection (Abari & Tyovenda, 2022). It is also referred by many as the stick multiplication method, line multiplication method and many other names. Suppose we want to expand (x+2) (x+3) using the Japanese multiplication method. We will have to consider (x+2) as a component and represent it with horizontal lines (i.e dotted line will be drawn to represent the x, then, we would leave a space and draw two lines to represent the 2) and (x+3) will be considered as another component to be represented with the vertical lines (i.e dotted line will be drawn to represent the x which will intersect with the horizontal lines of x and 2, then we will leave a space and draw another three lines to represent the 3 which will also intersect the horizontal lines). The points at which the lines intersect are then counted to give the answer.



That is, (x+2) (x+3) = x^2+5x+6. According to Abari and Tyovenda, (2022), the Japanese multiplication method can facilitate students' visualization of mathematics. This implies that Japanese Multiplication pedagogical approach is capable of stimulating Students Interest in Mathematics.

Interest is the psychological state of engaging or having the tendency to reengage in a particular context in the course of time (Hidi & Renninger, 2006). According to Terna and Eraikhuemen (2017), interest is the state of wanting to know or learn about something or somebody. Udegbe (2009) described interest as a disposition, attitude and feeling of an individual towards an activity, which shows behaviorally, the extent at which the person likes to participate in the activity. Interest plays a significant role in teaching and learning. Before knowledge in any form can affect character, there must be interest. The mind must get absorbed in the facts with which it has to deal and make them its own. It is crystal clear that interest is closely associated with learning as it allows improving and complementing the introduction of an object, to guide meaningful learning, to improve the long-term memory as well as a source of knowledge and orientation of motivation for further learning (Azmidar, Darhim & Jarnawi, 2017). Students tend to engage themselves in deeper learning on a particular subject when they have an interest in it. Interest towards mathematics learning could be considered as a predictor for mathematics performance (Heinze, **Reiss, & Franziska**, 2005).

Performance is the measure of what the students have accomplished or done. It can be accessed through test, assignment, or examination results (Abari & Tyovenda, 2021). A high-performance result comes from appropriate behaviour and the effective use of required knowledge, skills, and competencies. A performance assessment is a way to evaluate, that allows students to demonstrate their knowledge of a particular concept through application. Using performance assessment for mathematics is a great way to help students develop high-level thinking skills and apply what they know. There is a large body of international research on gender differences in academic performance in mathematics. Education has been considered among the basic rights of human beings. From the learning perspective, the gender has seemed to play a significant role. It plays an essential role in motivation, attitudes, and achievement of students (Mousa, 2017).

Gender refers to the social attributes and opportunities associated with being male and female. Adigun, Onihunwa, Sada, and Adesina (2015) affirms that gender is the range of physical, biological, mental, and behavioural characteristics pertaining to and differentiating between the feminine and masculine (female and male) population. The importance of examining performance in relation to gender is based mainly on the socio-cultural differences between girls and boys (Abari& Andrew, 2021).

Purpose of the Study

Mathematics is key to the realization of a nation's scientific and technological aspirations. Despite its importance, there has been proven evidence of continued low interest and poor performance in the subject by the Nigerian students (Terna & Eraikhuemen, 2017). The importance of mathematics in day-to-day activities is no longer news. However, what remains news is the fact that students' interest and performance in mathematics has not improved significantly despite its importance, not even with the introduction and use of technology in mathematics (Olalekan, 2006). Can the Japanese multiplication in expanding quadratic expression improve students' interest and performance in mathematics? Hence, the main purpose of this study is to investigate into the effect of Japanese multiplication on students' interest and performance in quadratic expansion. Specifically, the study seeks to:

i. determine the difference in the mean performance scores of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional Approach.
ii. determine the difference in the mean performance scores of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA)
iii. determine the difference in the mean interest rating of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional Approach.
iv. determine the difference in the mean interest rating of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA).

Research Questions: The following research questions were asked to guide the study:

i. What is the difference in the mean performance scores of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional method?
ii. What is the difference in the mean performance scores of male and female

secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA)?

iii. What is the difference in the mean interest rating of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional method?

iv. What is the difference in the mean interest rating of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA)?

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

i. There is no significant difference in the mean performance scores of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional method.

ii. There is no significant difference in the mean performance scores of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA).

iii. There is no significant difference in the mean interest rating of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional method.

iv. There is no significant difference in the mean interest rating of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA).

METHODOLOGY

The design adopted for this study was quasi-experimental design. The population for this study is all the junior secondary school one (JSS1) students in the co-education secondary schools in Makurdi Local Government Area of Benue State. The sample of students for this study was 15 students drawn from the selected secondary schools.

Forthis research work, Expansion Performance Test (EPT) and Mathematics Interest Inventory (MII) were used. The EPT is a test instrument that covers all the areas of algebraic expansion that will be taught regarding this study. The EPT is a ten (10) items multiple choice (with options A – D) instrument prepared for JSS1. The instrument was administered to a few respondents in pre-test exercise. The MII is divided into two sections (Section A and B). Section A contains the Bio-data of each respondent, while section B contains information on the research problem. A Likert-type scale of Strongly Agree, Agree, Disagree and Strongly Disagree was used to determine the Interest of the Students in Quadratic Equation.

The researchers administered the pre-EPT, pre-MII, post-EPT and post-MII to all the JSS1students in the two groups. The pre-EPT, pre-MII, post-EPT and post-MII were administered to the selected groups at different times to avoid interaction effect. Data collected were analyzed using descriptive statistics of mean and standard deviation to answer the research questions while the hypotheses were tested at 5% significance level using the Analysis of Covariance (ANCOVA).

RESULTS

The data is presented according to research questions and hypotheses

Question 1: What is the difference in the mean performance scores of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional method?

Table 1: Mean Performance Scores and Standard Deviation by Groups

Group	Pretest		Posttest		
	□	SD	□	SD	Mean Difference
JMPA	44.38	10.16	63.13	10.10	18.75
Traditional Approach	44.29	15.12	61.43	25.45	17.14
Total	44.35	12.64	62.28	17.78	1.61

In table 1, the mean pretest score for the JMPA is 44.38 with standard deviation of 10.16 and the mean pretest score for the traditional approach is 44.29 with a standard deviation of 15.12. this implies that before the administration of the test, both the students in the experimental and control group were at the same level of performance. However, the mean of posttest scores for the JMPA is 63.13 with standard deviation of 10.10 while the mean of the posttest score for the traditional approach is 61.43 with standard deviation of 25.45. The mean difference of the experimental and control group is 18.75 and 17.14 respectively. This implies that both groups improve upon their performance in the mathematics taught during this period, however, with the JMPA having a prevailing performance. To ascertain the significant difference of the group performance, hypothesis 1 was tested at 5% level of significance.

Hypothesis 1: There is no significant difference in the mean performance scores of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional method.

Table 2: Summary of ANCOVA Result of Students Performance in both groups

Source	Type III Sum of squares	df	Mean Square	F	Sig.
Corrected Model	3296.895[a]	2	1648.44713.676	.001	
Intercept	45.0851	45.085	.374	.552	
Pretest	3286.1511	3286.15127.263	.000		
Group	9.374	1	9.374.078	.785	
Error	1446.43812	120.537			
Total	63025.000	15			
Corrected Total	4743.333	14			

a. R Squared= .695 (Adjusted R Squared= .644)

From table 2, the p-value for groups is 0.785. Hence p>0.05, the null hypothesis is accepted. This implies that there is no significant difference in the mean performance scores of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional method. It therefore means that both the students in the experimental and control were at the same level of performance even after the administration of the test.

Question 2: What is the difference in the mean performance scores of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA)?

Table 3: Mean Performance Scores and Standard Deviation of Male and Female Students

Group	Pretest		Posttest		
	?	SD	?	SD	Mean Difference
Male	46.00	10.84	65.00	14.14	19.00
Female	41.67	10.41	60.00	12.00	18.33
Total	43.84	10.63	62.50	13.07	0.67

In table 3, the mean pretest performance score for male and female students in the experimental group is 46.00 and 41.67 respectively while the mean of posttest scores for the male and female students is 65.00 and 60.00 respectively. However, the mean difference in the performance score for the male and female students is 19.00 and 18.33 respectively. This shows that both the male and female students improved upon their performance in mathematics. However, hypothesis 2 was tested at 0.05 to ascertain the level of significant difference of their performance scores.

Hypothesis 2: There is no significant difference in the mean performance scores of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA).

Table 4: Summary of ANCOVA Result of Male and Female Students Performance

Source	Type III Sum of squares	df	Mean Square	F	Sig.
Corrected Model	200.698[a]	2	100.349	.776	.509
Intercept	594.715	1	594.715	4.602	.085
pretest	153.823	1	153.823	1.190	.325
Gender	15.511	1	15.511	.120	.743
Error	646.177	5	129.235		
Total	32725.000	8			
Corrected Total	846.875	7			

a. R Squared= .237 (Adjusted R Squared= -.068)

From table 4, the p-value for gender is 0.743. Hence p>0.05, the null hypothesis is accepted. This implies that there is no significant difference in the mean performance scores of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA). Hence both the male and female students that were exposed to the Japanese Multiplication Pedagogical Approach (JMPA) improved equally and greatly on their performance in mathematics.

Question 3: What is the difference in the mean retention scores of students taught mathematics using Cognitive Reasoning Strategy (CRS) and those taught using the conventional approach?

Table 5: Mean Retention Scores and Standard Deviation by Groups

Group	Pretest		Posttest		Mean Difference
	SD		SD		
JMPA Approach	72.50	13.89	90.63	10.50	18.13
Traditional Approach	67.86	16.04	75.00	10.00	7.14
Total	70.18	14.97	81.32	10.25	10.99

Results in table 5 shows that the mean interest rating of students taught quadratic expansion with Japanese Multiplication Pedagogical Approach (JMPA) is 90.63 with standard deviation of 10.50 while that of the students taught quadratic expansion using the traditional approach is 75.00 with a standard deviation of 10.00. The mean difference in the JMPA and the traditional approach is 18.13 and 7.14 respectively. It therefore means that the mean interest rating of the students taught quadratic expansion using the JMPA is higher than those taught quadratic expansion with the traditional approach. This implies that the students taught quadratic expansion using the JMPA showed higher interest in learning mathematics than the students taught using the traditional approach. To show if the difference in the mean interest rating of students in the two groups is significant, hypothesis 3 was tested at 0.05 level of significance.

Hypothesis 3: There is no significant difference in the mean interest rating of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional method.

Table 6: Summary of ANCOVA Result of Students Interest in both groups

Source	Type III Sum of squares	df	Mean Square	F	Sig.
Corrected Model	1320.278[a]	2	660.1398.226	.006	
Intercept	1799.665	1	1799.66522.424	.000	
pretest	408.8191	408.8195.094	.043		
Group	699.739	1	699.7398.719	.012	
Error	963.0561280.255				
Total	106450.00015				
Corrected Total	2283.333	14			

a. R Squared = .578 (Adjusted R Squared =.508)

From table 6, the p-value for groups is 0.012. Hence $p<0.05$ the null hypothesis is rejected. This implies that there is a significant difference in the mean interest rating of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional method. It therefore means that the students who were exposed to the JMPA showed higher interest in learning mathematics as compared to the students that were taught using the traditional approach.

Question 4: What is the difference in the mean interest rating of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA)?

Table 7: Mean Retention Scores and Standard Deviation of Male and Female Students

Group	Pretest		Posttest		Mean Difference
□ SD	□	SD			
Male	71.00	16.73	90.00	12.75	19.00
Female	75.00	10.00	91.67	7.64	16.67
□ Total	□ 73.00	13.37	90.84	10.20	2.33

Results in Table 7 shows that the mean interest rating of the male and female students in the JMPA is 90.00 and 91.67 respectively. The result indicates that there is no much difference between the male and female students' mean interest rating in mathematics. However, hypothesis 4 was tested to determine if the difference in the mean interest rating between male and female students is statistically significant or not.

Hypothesis 4: There is no significant difference in the mean interest rating of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA).

Table 8: Summary of ANCOVA Result of Male and Female Students Performance

Source	Type III Sum of squares	df	Mean Square	F	Sig.
Corrected Model	176.136[a]	2	88.068.739	.523	
Intercept	999.546	1	999.5468.389	.034	
pretest	170.9281	170.9281.435.285			
Gender.0951	0.95.001	.979			
Error	595.7395119.148				
Total	66475.0008				
Corrected Total	771.875	7			

a. R Squared= .228 (Adjusted R Squared= -.081)

From table 8, the p-value for gender is 0.979. Hence p>0.05, the null hypothesis is accepted. This implies that there is no significant difference in the mean interest rating of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA). It therefore means that both the male and female students demonstrated similar interest in mathematics.

Discussion

Result from hypothesis 1 shows that there is no significant difference in the mean performance scores of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional method. It therefore means that both the students in the experimental and control group were at the same level of performance even after the administration of the test. This result disagrees with the findings of Abari and Tyovenda (2022) who conducted a research on the effect of Japanese multiplication on students' achievement and retention in mathematics and found out that the students in the experimental group achieved higher than those in the control group. However, the finding is in line with that of Zengin and Kutluca (2012) who carried out a study to determine the effect of Geogebra on students' achievement in Trigonometry in Turkey and found that the students taught trigonometry with Geogebra achieved higher than those taught with the traditional method.

Result from hypothesis 2 shows that there is no significant difference in the mean performance scores of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA). Hence both the male and female students that were exposed to the Japanese Multiplication Pedagogical Approach (JMPA) improved equally and greatly on their performance in mathematics. This result agree with the findings of Abari, Gimba, Hassan, Jiya, Chado,Gana and Koroka (2019) who conducted a research on effects of Geogebra Instructional Package on Secondary school students achievement in Geometry in Makurdi Metropolis of Benue State and discovered that Geogebra instructional package is not gender bias in terms of improving students' achievement in geometry. The result is also in agreement with the findings of Gambari, Falode and Adebenro (2014) who carried out a study on the effectiveness of computer animation and geometry instructional model on mathematics achievement and retention on junior secondary school students in Minna, Nigeria and found that, there was no significant difference reported in the post test performance scores of male and female students taught geometry using computer animation and instructional model respectively.

Result from hypothesis 3 shows that there is a significant difference in the mean interest rating of secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA) and those taught using the Traditional method. It therefore means that the students who were exposed to the JMPA showed higher interest in learning mathematics as compared to the students that were taught using the traditional approach. This finding disagrees with the findings of Shu and Luan (2019) who conducted a research to examine Students' interest towards mathematics in technology-enhanced learning context and the results of the descriptive statistical analyses revealed that the students in both groups were relatively interested in mathematics.

Result from hypothesis 4 shows that there is no significant difference in the mean interest rating of male and female secondary school students taught quadratic expansion using the Japanese Multiplication Pedagogical Approach (JMPA). It therefore means that both the male and female students demonstrated similar interest in mathematics. The findings of this result agree with that of Ghasemi& Burley (2015) which carried out a study to investigate gender differences in interest in mathematics and found out that there was almost no gender difference in interest in mathematics between fourth graders.

Conclusion

In conclusion, the study used Japanese Multiplication pedagogical approach to teach students quadratic expansion and measured the students' performance and interest and compared the learning outcomes with those of students taught quadratic expansion using the traditional

method. While there was no significant difference in the performance of students in quadratic expansion between the experimental and control group, there was significant difference in mean interest rating of students taught quadratic expansion in the experimental and control group. The findings also suggested that there was no significant difference in the interest and performance of students taught quadratic expansion using Japanese Multiplication pedagogical approach.

Recommendations

The following recommendations were made based on the findings of the study:

1. More effort should be made by teachers to ensure that students develop interest in learning mathematics. When the topic is linked to what the students like to do; engagement deepens as they willingly spend time thinking and creating ideas in meaningful ways.

The study also recommended that teachers should deploy ethno-mathematics teaching strategies that can improve the learning outcome

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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 Deviat ion of Basic Education Students taught AWP AT in SOLVE Mnemonic Strategy and Conventional M ethod

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, $\propto$ **=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.

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 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 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 affects students' achievement and retention in mathematics.

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			

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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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.

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.

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?

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 lack-lustre attitude towards education in general.

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 & Rauseo, 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.

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:

$$\left(\frac{4+3+2+1}{4}\right) = \left(\frac{10}{4}\right) = 2.5 \text{ points}$$

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.

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.

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 a nchor 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 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 encoura ge 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 col laborate 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)

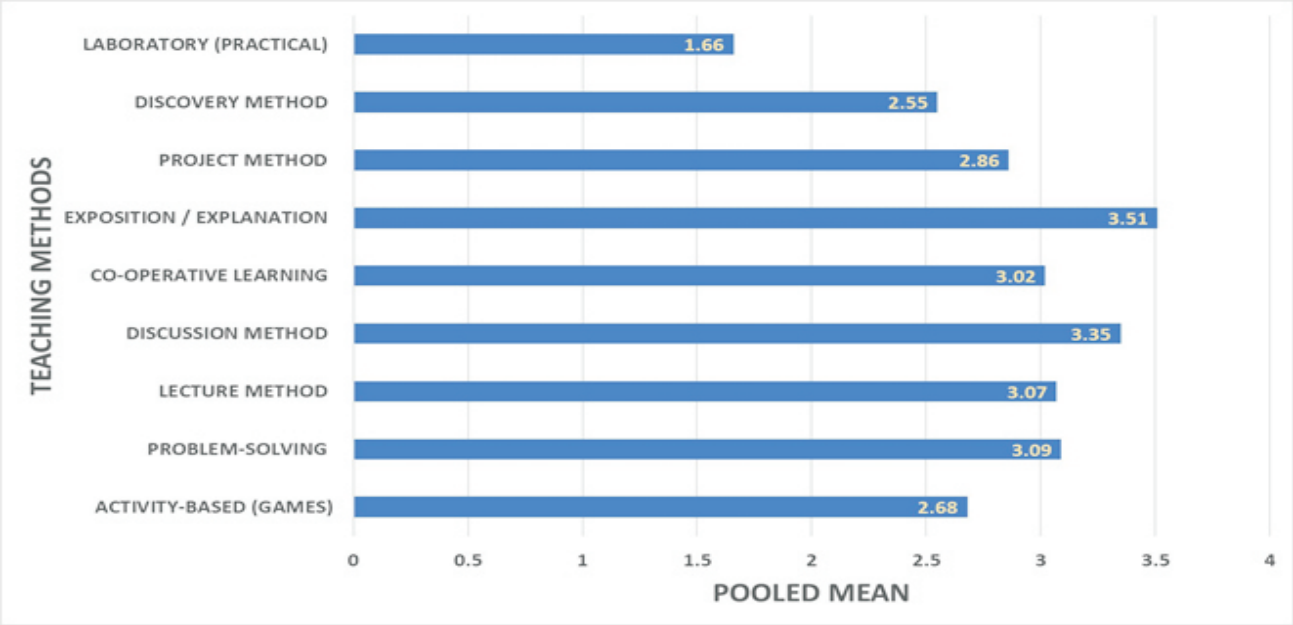

Fig. 1 Bar Graph of Research Question One responses

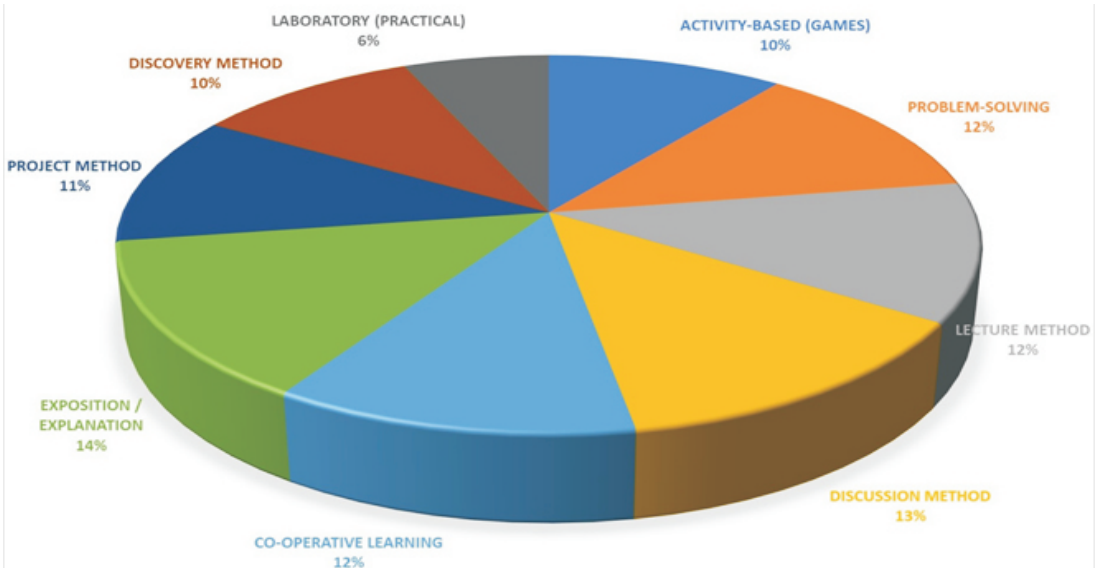

Fig. 2 Pie Chart of Research Question One responses in percentages

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.

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

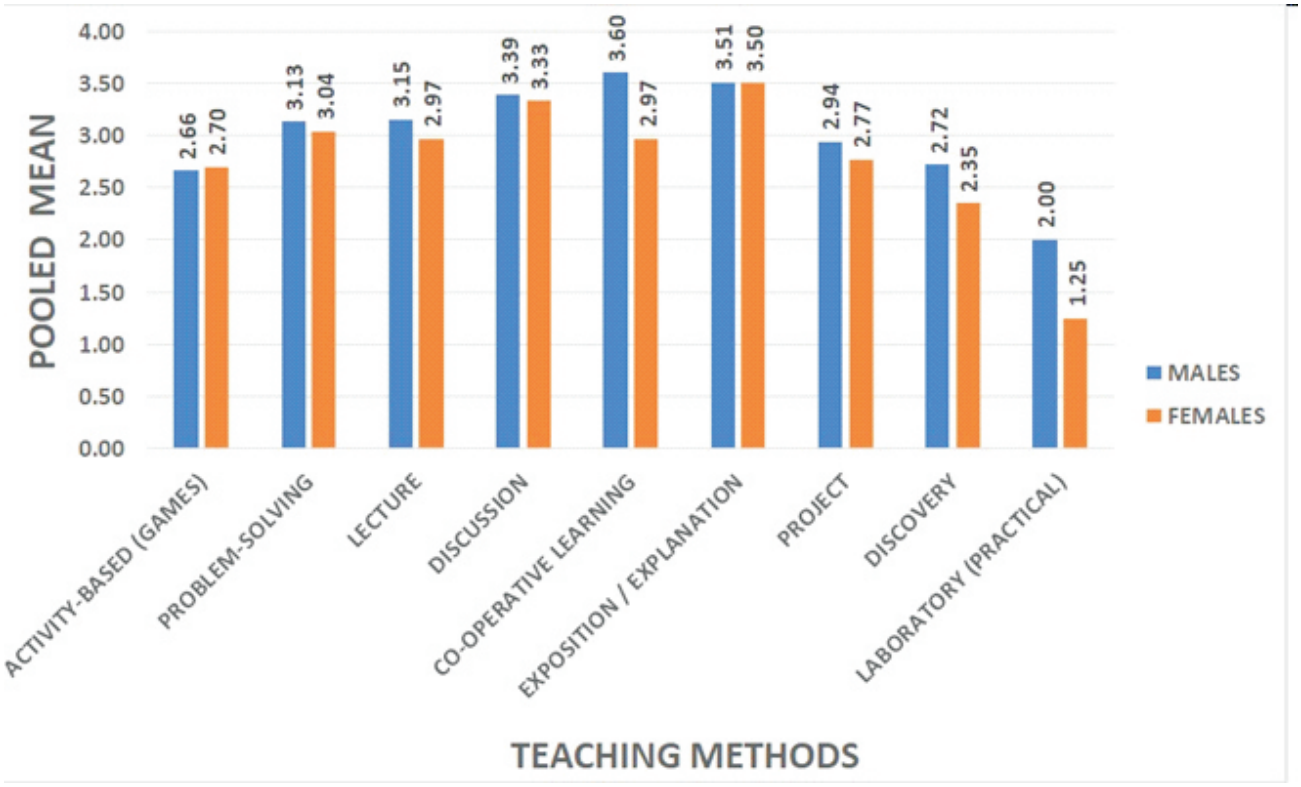

Fig. 3 Bar chart of Research Question 2 responses grouped by teaching methods

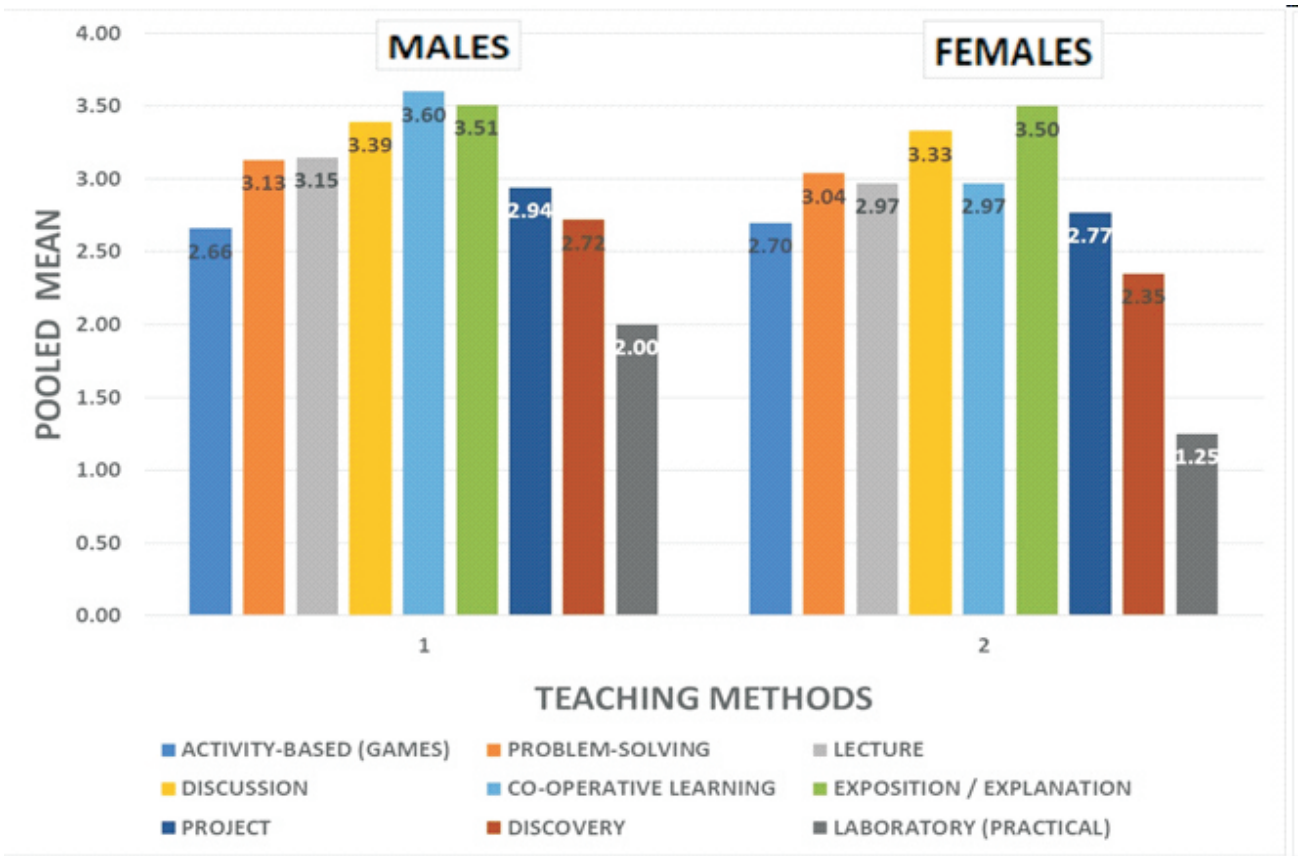

Fig. 4 Bar chart of Research Question 2 responses grouped by Gender

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.

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

METHODS	GRP A 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.

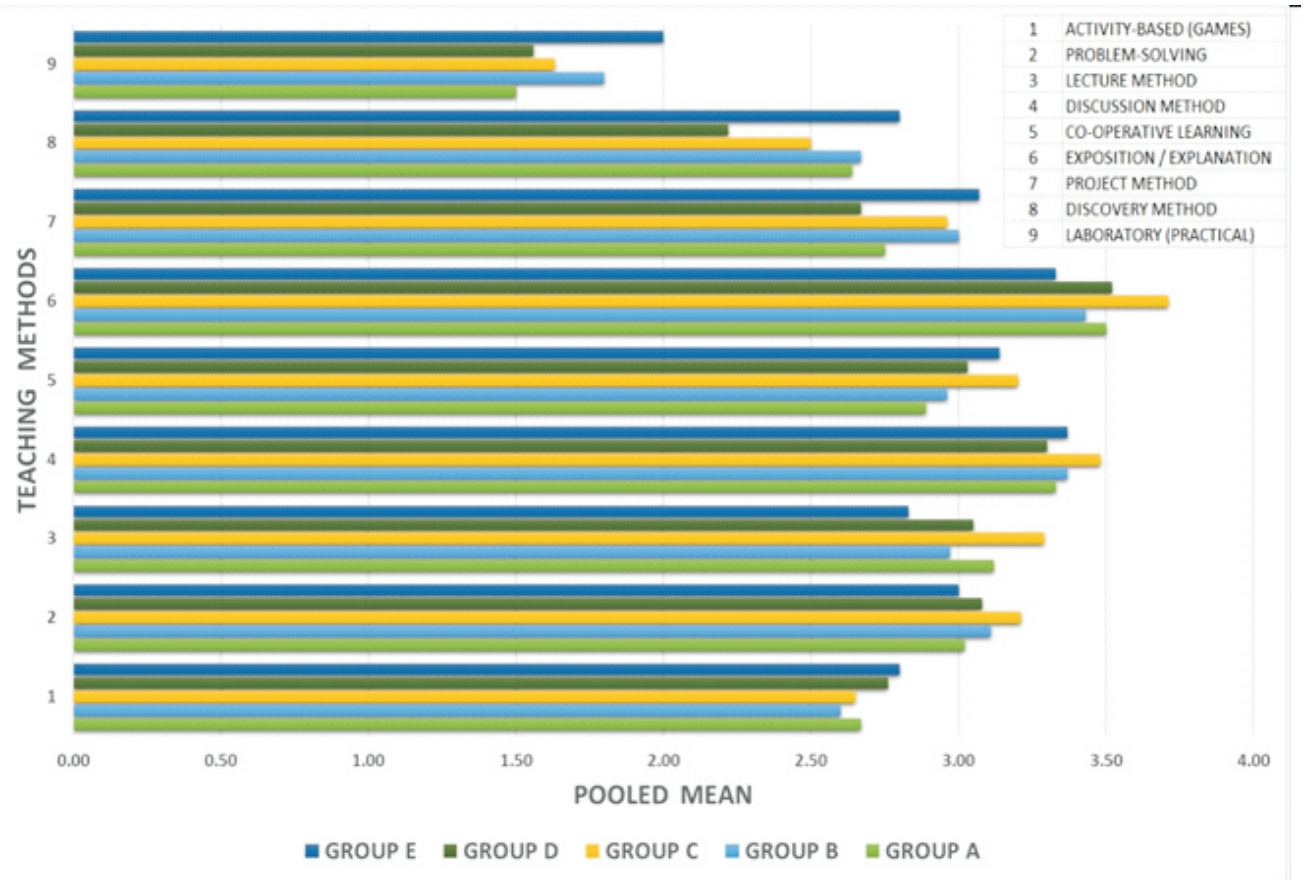

Fig. 5 Bar chart of Research Question 3 responses grouped by teaching methods

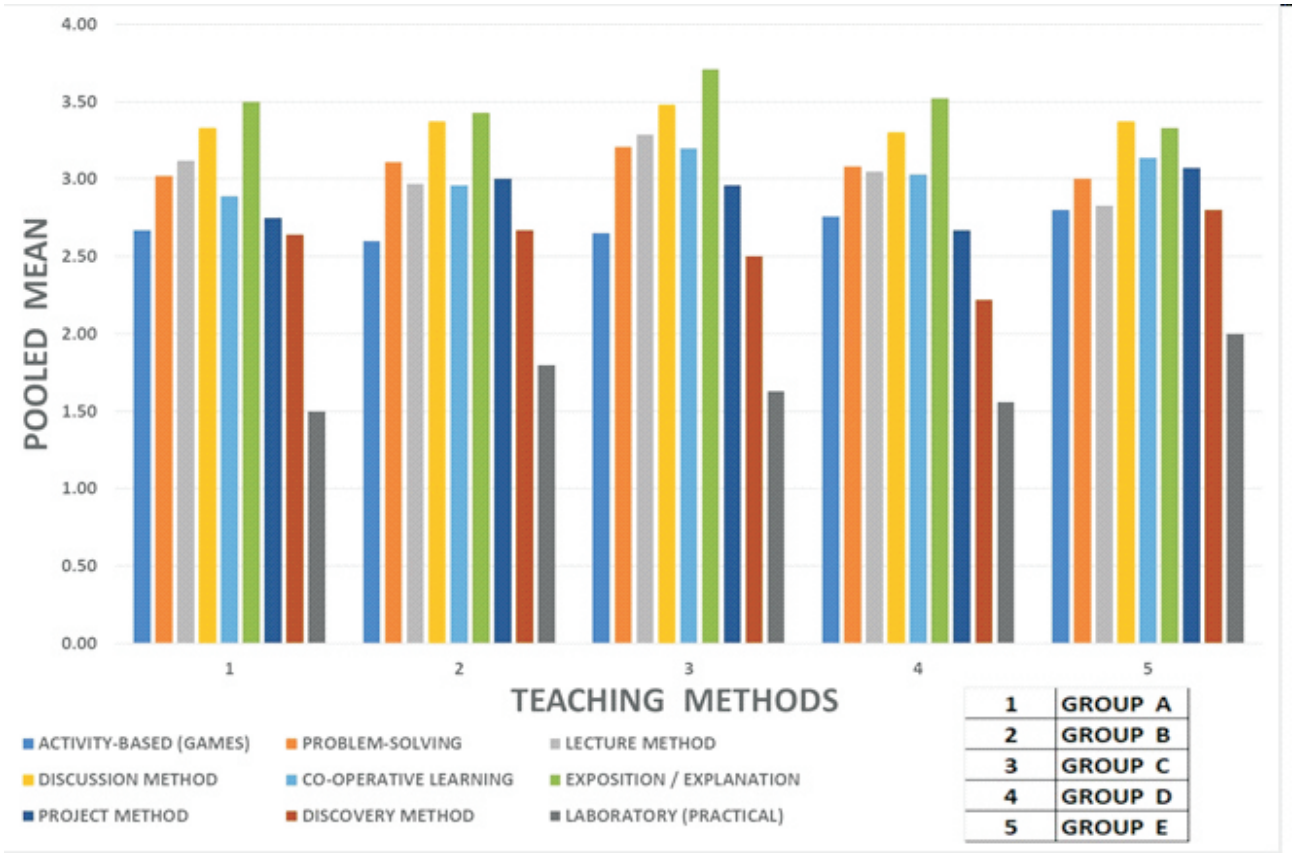

Fig. 6 Bar chart of Research Question 3 responses grouped by years of teaching experience

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.

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

METHODS	GRP A (NCE)	GRP B (B.Sc., B.Ed., PGD)	GRP C (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.

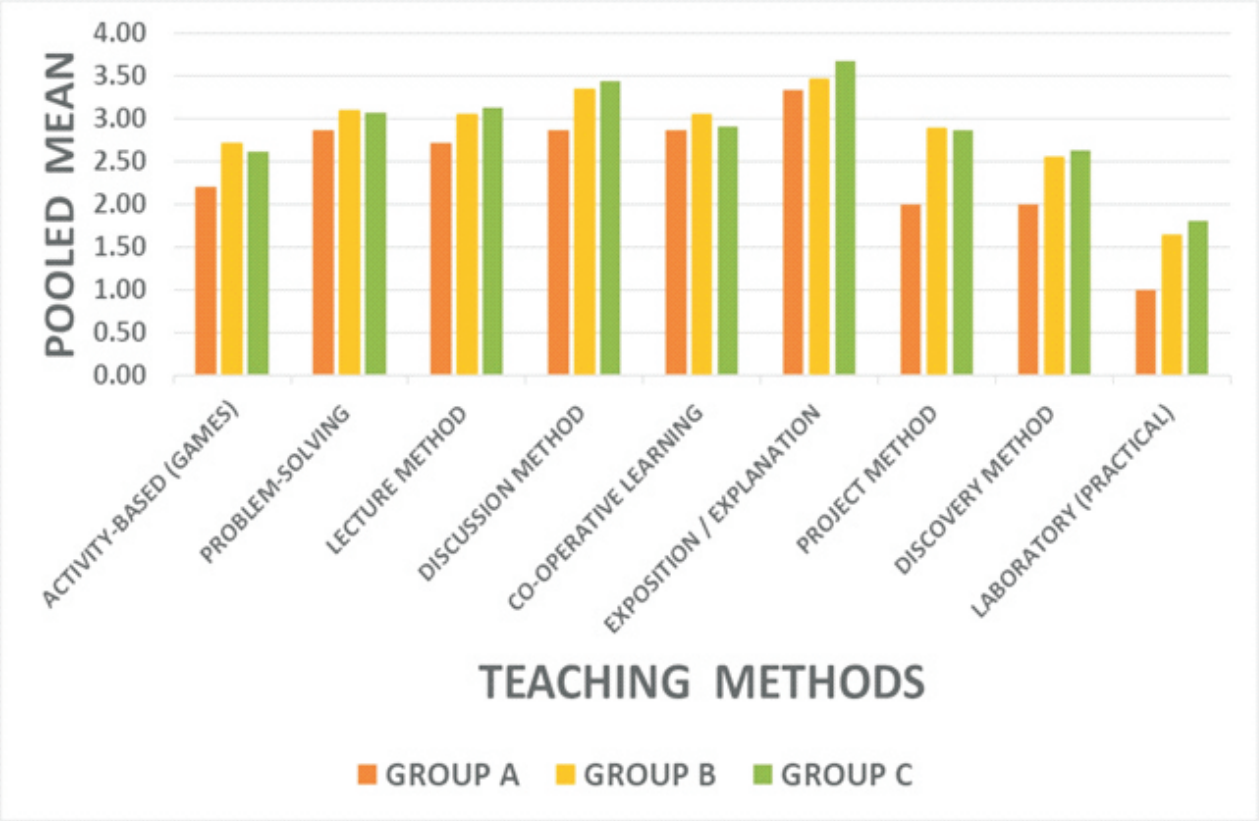

Fig. 7 Bar chart of Research Question 4 responses grouped by teaching methods

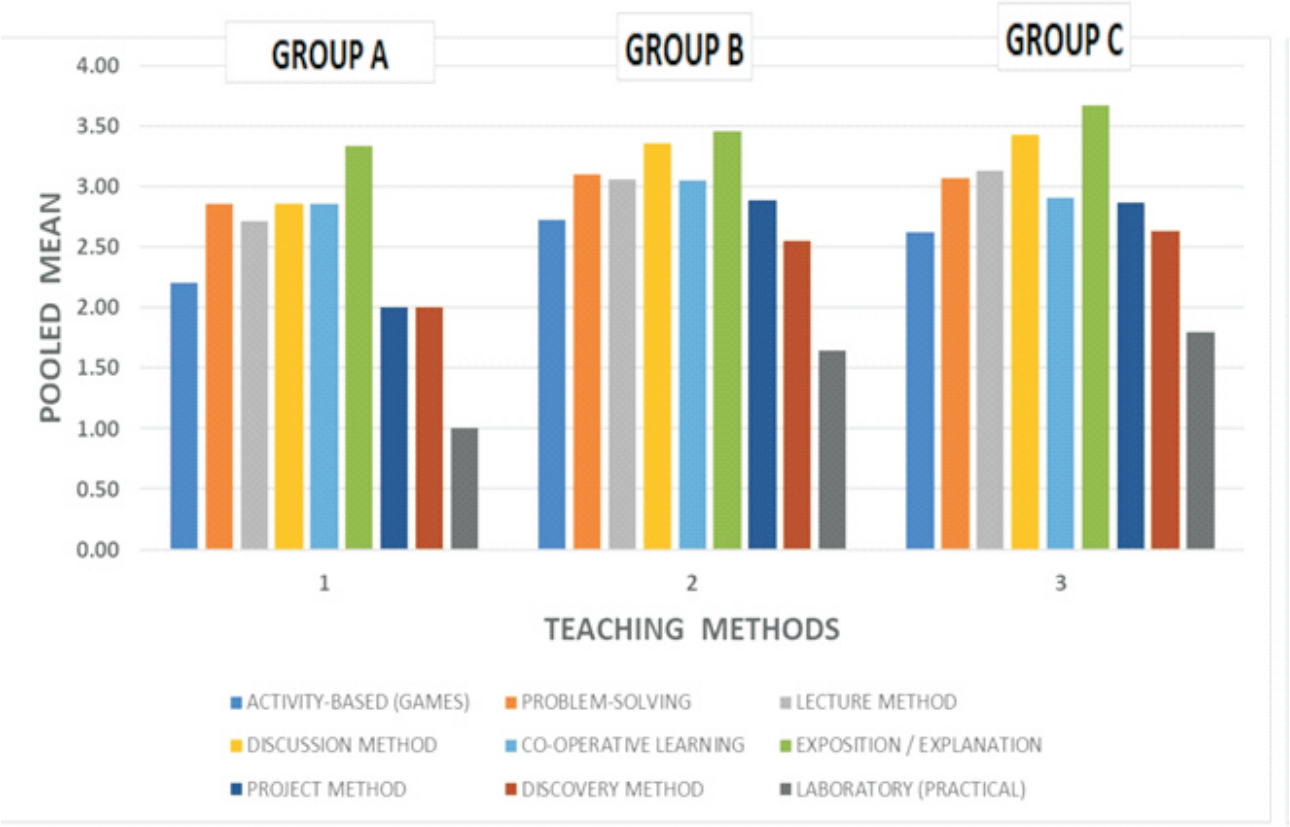

Fig. 8 Bar chart of Research Question 4 responses grouped by teacher's qualification

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.

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.

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 INTERACTIVEWHITE-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 studyto 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 it's 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, 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 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 ofinteractive 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.
3. 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;

1. To what extent does the academic achievement of the experimental group and the control group differ before applying the treatment (intervention).
2. Was there any difference in academic achievement of the students after treatment (intervention)
3. 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;

HO_1; There is no significant difference in the mean achievement of the experimental and control group before intervention

$H0_2$: There is no significant difference in the mean achievement of the experimental and control group after intervention.

$H0_3$: 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

heaving 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

$H0_1$: 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.

$H0_2$: 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				

P≥0.05

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 Tarmizi 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 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 η2=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.

Ho1: 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.	PartialEta. 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 1was 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, Sch effe 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

$H_0$2: 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.

$H_0$3: T here 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 Mathemati cs ($F_{(2,308)} = 1.143$, $P > 0.05$, $\eta^2 = 0.015$). 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 Pekhonen, (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 Pekhonen, (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 IT'S 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 then. 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 N = 48**		**Students 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	⍰	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	?	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 4	A 3	SD 2	D 1	TOTAL	X	DECCISON
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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MATHEMATICAL MODELLING METHOD AND STUDENTS' ACHIEVEMENT IN DIFFERENTIATION IN THE BAYELSA STATE'S SOUTHERN IJAW LOCAL GOVERNMENT AREA

Abstract

In the Southern Ijaw local government area, this study examined the effects of mathematical modelling on students' achievement in differentiation. To direct the investigation, three research questions and three null hypotheses were developed. The Mathematics Differentiation Achievement Test (MDAT) was the tool utilised to collect the data. Using Kuder Richardson formula 20, the reliability coefficient of the instrument was validated and determined to be 0.77. Utilising mean, standard deviation, and ANCOVA test statistics, the study's data were examined. The significance level for testing the three hypotheses was 0.05. The findings revealed a significant achievement gap between students who received mathematical modelling instruction and those who received lecture instruction. The gender and geographic location of the pupils showed a non-significant difference. It was recommended, among other things, that mathematics teachers be encouraged to use mathematical modelling in teaching differentiation in mathematics.

Keywords: Achievement, Mathematical Modelling, Gender, Location

Introduction

The language of mathematics being frequently utilized as a tool in many other subject areas, it is one of the most important disciplines studied in schools. In most cases, it is a prerequisite or requirement for admission to universities in all fields of the physical and social sciences, including technology, engineering, and economics and accounting. In most nations, including Nigeria, mathematics is one of the disciplines that must be taught in both primary and secondary schools. Due to this, it frequently receives more time on a school timetable than other topics. The science of mathematics is the one that makes the inferences required to explain the underlying principles of the majority of fields of natural science and technology. It covers numerical data, amounts, measurements, variation, graphs, forms, volume, fractions, logarithms, indices, algebraic operations, and equations. A growing and dynamic collection of knowledge, mathematics also serves as a method for recognizing, expressing, and resolving issues in a variety of academic fields because it is a prerequisite for enrolment in post-secondary education in Nigeria, mathematics is taught in primary and post-primary schools there as a core topic.

The study of patterns and relationships, and the manipulation of numbers and other symbols to solve problems and understand the world around us is how the National Council of Teachers of Mathematics (NCTM) defines mathematics (NCTM, 2021). The definition emphases logical thinking and problem-solving as being very essential components of mathematics. Algebra, geometry, calculus, and statistics are only a few of the subfields that make up mathematics. It is a subject that is essential to our comprehension of the environment and is important to the development of science and technology.

It is impossible to overstate the importance of mathematics for achievement and personal development. At both the national and international levels, there is broad agreement that, in the twenty-first century, the only foundations for economic progress, viability, and stability are scientific and technology. This indicates that a country's economic growth mostly depends on the advancement of science and technology, which is impossible to achieve without a solid, efficient, and robust

mathematics education (Yusuf & Adigun, 2010).

Differential calculus is an area in mathematics which deals with the rate of change and curve slopes. It focuses on examining how a function responds to variations in its input variables or extremely brief intervals. The derivative is the fundamental idea of differential calculus. The derivative of a function shows how quickly the function is changing at any particular point. It reveals how the function is evolving when its input variable or variables vary. F'(x) or dy/dx, where 'dy' stands for the infinitesimal change in the function's output and 'dx' stands for the infinitesimal change in the function's input, is used to denote a function's derivative.

The derivative of various functions can be found using differentiation principles and techniques. For instance, the power rule asserts that a function's derivative is given by $f'(x) = nx^{(n-1)}$ if it has the form $f(x) = x^n$, where 'n' is a constant. For obtaining derivatives of sums, differences, products, and compositions of functions, there are similar rules.

Differential calculus has a wide range of applications and is used in many disciplines, including physics, engineering, economics, and biology. It can be employed to address optimization issues, discover the maximum and minimum values of functions, research function behaviour, examine motion, simulate population increase, and more. In conclusion, differential calculus focuses on understanding curve slopes and rates of change using the idea of derivatives. It offers a potent mathematical tool for deciphering and studying how functions behave in response to their input variables.

Despite how vital the topic is, educators and psychologists continue to be deeply concerned by the enormous and ongoing failures of Nigerian students in it (Usher, 2009). This poor achievement concern was expressed in the reports of education stakeholders and relevant established examination authorities (WAEC Chief Examiner's report, 2010; Fajemidagba, 2010; Aminu, 2011). Giginna (2013) also emphasize this, by the frequency with which students fail in large numbers in both internal and external exams.

The general performance of the candidates in mathematics for the May/June 2010, 2011, 2012, and 2015 examinations (WAEC, 2010, 2011, 2012, & 2015) did not differ considerably from that of the previous years, according to the reports from the West African Examinations Council head examiners. Although the rate of failure in all subjects appeared to have decreased when compared to previous years (WAEC, 2013 & 2014), the Chief Examiners also reported that candidates' performance in mathematics is declining and getting worse every year. Additionally, there is still a low percentage of students passing mathematics excellently.

The employment of conventional approaches is insufficient in addressing the demands of teaching and learning, innovative instructional strategies need to be employed, according to the West Africa Examinations Council (WAEC, 2010). Unfortunately, bad teaching practices by instructors have been linked to low mathematics achievement (Zimmerman & Schunk, 2010). However, the researcher's objective is to use a teaching approach called mathematical modelling to tackle this issue.

Mathematical modelling approach, according to Neumaier (2004), is the skill of turning application-specific issues into tractable mathematical formulations whose theoretical and numerical analysis offers information, solutions, and direction helpful for the original application. According to Kharisudin and Cahyati (2020), the technique of simulating real-world issues so that a solution can be quickly found is the focus of the mathematical modelling strategy. Kharisudin and Cahyati (2020) stated that mathematical modelling employs four steps. First, recognise the true issue. Create the mathematical model next. The second step is converting actual problems into mathematical terms. All values involved in the problem must be identified, along with any variables and constants that are chosen, and a symbol must be provided. The laws, theorems, and conditions that apply to situations are taken into consideration when creating mathematical

models. The choice of relevant laws and theorems demonstrates the connection between the relevant constants and variables. Finding the model solution is the third stage. The interpretation of model solutions as a form of problem solution is the final phase.

According to Kruthina (2018), students should be exposed to mathematical modelling early on because it is essential to modern science and human practice. This exposure will help students use mathematics to solve problems in the real world. This method allows students to realize how the arithmetic they are learning can be used in real-world situations. In addition to helping students understand why mathematics is essential, this can make the subject more exciting and engaging. It also forces them to use a variety of problem-solving techniques, such as logic, critical thinking, and data analysis. Students gain these abilities as they work through modelling issues and improve as problem solvers and improves mathematics comprehension, or the ability to comprehend mathematical ideas and how they relate to practical issues. This can improve students' academic progress by deepening their comprehension of mathematics and assisting them in making connections between various arithmetic concepts.

According to Ezeh (2013), gender is any physical or behavioral difference between men and women that is dependent on social or cultural factors. All students tend to find mathematics to be challenging, but female students tend to find it particularly challenging. Despite this, Hydres and Mertzb (2009) found that when developing educational curricula, the gender factor and student interests are frequently ignored. The main problems that may result in fundamental changes to the educational system and higher performance standards can be found by analysing the various barriers that prevent male and female students from achieving academically and their corresponding interests.

Gender of students are found both in urban and rural schools. This makes location of schools very important as regard achievement of students in schools. The location of the school provides different experiences for each student as regard the real-life existence in the location. Mathematical modelling strategy uses the real-life problems in the area for the understanding of concepts, principles and problem solving. It is in this regard that the achievement of students in urban and rural location needs to be examine to ascertain the effectiveness of using mathematical modelling in these areas.

Statement of the Problem

Statistics from examination bodies like WAEC, NECO, NABTEB, and GCE attest to the decline in student performance as a result of the difficulty students faced in comprehending mathematical problems and applying formulas. The performance of students in mathematics has been quite unsatisfactory over the years in Nigeria. According to earlier studies, this is clear from the rate of widespread student failure in both internal and external examinations. Despite the government's efforts to build and upgrade infrastructure in Primary and Secondary schools across the country, students' performance in internal and external exams, such as State Common Mock Examinations and other qualifying exams for tertiary institutions, is still subpar and falls short of the public's expectations. Numerous recommendations for improvement have been made as a result of concerns regarding students' arithmetic performance. Sadly, the recommendations centre on ineffective teaching methods as the main contributor to students' low performance. This study is interested in determining whether a mathematical modelling method can raise students' mathematics achievement in differentiation.

Purpose of the Study

This study's major goal was to look into how mathematical modelling Method affected students' academic performance in secondary schools in the Ogbia Local Government Area of Bayelsa State. In particular, the study aimed to:

1. Compare the mean achievement scores of math students who were taught using

mathematical modelling and those who were taught with lecture method.

2 Determine if the achievement of male and female students taught using mathematical modelling method differ.

3. Compare urban and rural students' achievement taught using mathematical modelling method.

Research Questions

The following research question guided the study.

1. What are the mean achievement scores of students who received instruction using mathematical modelling and those were taught with lecture method?
2. What are the mean achievement scores for male and female students who were taught mathematics with mathematical modelling?
3. What are the mean achievement scores of urban and rural students who were taught mathematics with mathematical modelling?

Hypotheses

The .05 level of significance was used to formulate and evaluate the subsequent null hypotheses.

1. The mean achievement score of students who were taught using mathematical modelling compared to those who were taught using lecture method not differ significantly.
2. The mean achievement scores of male and female students taught using mathematical modelling do not differ significantly.
3. The mean achievement scores of urban and rural students taught using mathematical modelling students do not differ significantly.

Research Methods

The pre-test post-test non-equivalent control group design was the quasi-experimental research design used in this investigation. There was no any random assignment of research subjects; instead, this design applied intact classes.

All Senior Secondary Two (SSS II) Mathematics students in coeducational senior secondary schools in Southern Ijaw Local Government Area, Bayelsa State, during the academic year 2022/2023 comprised the target population for this study. In Southern Ijaw, there are a total of 45 secondary schools, serving 1,962 students (899 men and 1,063 females). 246 SSII mathematics students (112 males and 134 females) made up the study's sample, which was chosen using stratified random sampling method based on location. Out of the 17 coeducational secondary schools in Southern Ijaw LGA, two were selected from urban and two from rural. Two intact SSS II classes were given the traditional lecture form of teaching (one urban and one rural) the other two intact classes were given the mathematical modelling instructional strategy (one urban and one rural).

A two-section Mathematics Differentiation Achievement Test (MDAT) was created by the researcher. Section A asked for optional student demographic data, and Section B had 30 multiple-choice questions on differentiation. The test questions were taken from previous WAEC and NECO question papers, and they matched the material of the SSS II syllabus. Two subject matter experts and two classroom teachers assessed the face and content of the instrument. To make sure the structure, planning, and organization of the instrument were in line with the study's learning area, their comments and recommendations were taken into consideration. 20 SSSII students who weren't in the student sample were given the test once in order to determine the reliability of the instrument. The Kudar Richardson (KR-20) formula was used to analyse the data, and the resulting reliability coefficient was 0.86.

Regular mathematics teachers in the sample schools were gave the students a pre-test to ascertain their initial equivalency before the therapy. The experimental group was taught using a mathematical modelling strategy after

the pre-test, while the control group was taught using the traditional lecture method. Both groups were given a post-MDAT.

The marked scripts of the students in the experimental and control groups were used to gather the study's data. The study data were analysed using the mean and standard deviation. Additionally, a 0.05 significance level covariance analysis was used to assess the hypotheses.

Research Question One

What are the mean achievement scores of students who received instruction using mathematical modelling and those who were taught with Lecture?

Table 1:
Adjusted Mean Achievement Scores and Standard Deviation of Students Taught Differentiation Using Mathematical Modelling and Lecture Methods

Method	N	Adjusted Mean	SD
Mathematical Modelling	125	20.53	3.37
Lecture	121	16.80	4.32

Table 1, shows that the mean achievement scores of students taught using modelling method is 20.53 while those taught using lecture is 16.80. The results indicates that Students taught using modelling method had a higher mean achievement score than those taught using lecture method.

Research Question Two

What are the mean achievement scores for male and female students who were taught mathematics with mathematical modelling?

Table 2:
Adjusted Mean Achievement Scores and Standard Deviation of Male and Female Students Taught Differentiation Using Modelling Method

Gender	N	Adjusted Mean	SD
Male	60	20.95	3.23
Female	65	20.17	3.49

Table 2, shows that the mean achievement scores of male and female students taught using modelling method are 20.95 and 20.17 respectively. The results indicates that male students taught using modelling method had a higher mean achievement score than their female counterparts.

Research Question Three

What are the mean achievement scores of urban and rural students who were taught mathematics with mathematical modelling?

Table 3:
Adjusted Mean Achievement Scores and Standard Deviation of Urban and Rural Students Taught Differentiation Using Modelling Method

Location	N	Adjusted Mean	SD
Urban	66	20.92	3.45
Rural	59	20.12	3.27

Table 3, shows that the mean achievement scores of urban and rural students taught using modelling method are 20.92 and 20.12 respectively. The results indicates that urban students taught using modelling method had a higher mean achievement score than their rural counterparts.

Hypothesis One

The mean achievement score of students who were taught using mathematical modelling compared to those taught using lecture method does not differ significantly.

Table 4:
ANCOVA Analysis of Achievement Scores of Students Taught Differentiation Using Mathematical Modelling and Lecture Methods

Source of Variation		Sum of Squares	df	Mean square	f	P-value
Covariates	Pretest	19.55	1	19.55	1.30	.26
Main Effects	Methods	851.71	1	851.71	56.73	.00
Residual		3648.49	243	15.01		
Total		4519.74	245	18.45		

Table 4 shows that the calculated probability value (P-value) of methods is .00 which is less than the alpha level of 0.05. Hence, null hypothesis is rejected. This implies that the mean achievement score of students who were taught using mathematical modelling compared to those taught using lecture method differ significantly

Hypothesis Two

The mean achievement scores of male and female students taught using mathematical modelling do not differ significantly.

Table 5:
ANCOVA Analysis of Achievement Scores of Male and Female Students Taught Differentiation Using Modelling Method

Source of Variation		Sum of Squares	df	Mean square	f	P-value
Covariates	Pretest	36.25	1	36.25	3.26	.07
Main Effects	Gender	18.65	1	18.65	1.68	.20
Residual		1356.11	122	11.12		
Total		1411.01	124	11.38		

Table 5 shows that the calculated probability value (P-value) of gender is .20 which is greater than tshe alpha level of 0.05. Hence, null hypothesis is not rejected. This implies that the mean achievement scores of male and female students taught using mathematical modelling do not differ significantly

Hypothesis Three

The mean achievement scores of urban and rural students taught using mathematical modelling students do not differ significantly.

Table 6:
ANCOVA Analysis of Interest Scores of Students Taught Quadratic Equations Using Slack, WhatsApp and without Resource

Source of Variation		Sum of Squares	df	Mean square	f	P-value
Covariates	Pretest	36.25	1	36.25	3.26	.07
Main Effects	Location	19.61	1	19.61	1.77	.19
Residual		1355.15	122	11.11		
Total		1411.01	124	11.38		

Table 6 shows that the calculated probability value (P-value) of gender is .19 which is greater than the alpha level of 0.05. Hence, null hypothesis is not rejected. This implies that the mean achievement scores of urban and rural students taught using mathematical modelling students do not differ significantly.

Discussion of Findings

The findings indicated that students who were taught using mathematical modelling achieved significantly better than those taught using lecture method. The significant difference could be attributed to mathematical modelling forcing students to use a variety of problem-solving techniques, such as logic, critical thinking, and data analysis. Students gain these abilities through work of modelling issues and improve as problem solvers which improves the ability to comprehend mathematical ideas and how they relate to practical issues. The practical nature of the strategy i.e., taking students into the real world of how the concepts of differentiation applies in different scenario may have given the edge above their counters taught using lecture method. The findings are in line with that of Arseven (2015), who stated that the importance of mathematical knowledge lies in its association with real life and mainly what students come across daily.

The findings indicated that male and female students' achievement taught using mathematical modelling method did not differ significantly. The findings may have been due to both male and female students working together citing and using of models that may have best explained the concepts to them. The mutual working together may have also be responsible for the non-significant difference. The findings is an affirmation of the study of Ajai and Imoko (2015), who found that the equal achievement of male and female students were due to both seeing themselves as equals and capable of competing and collaborating in classroom activities.

The findings indicated that urban and rural students' achievement taught using mathematical modelling method did not differ significantly. The findings of the study on the non-significant achievement of in different location could be as result of the teachers in urban and rural location applying the teaching of the concepts using different models that can be seen by the students in their locations. This made the students acquainted with the concept as they could see it in their environment. This agrees with the findings of Ajai and Imoko (2015), who stated in their findings that rural students suffer disadvantage not as a result of their attendance at rural schools but due to non-usage of effective methods of teaching.

Conclusion

Based on the findings of the study, it could be concluded that aroused students' achievement significantly due to its real-life application in teaching concepts. The method effectively brought male and female students together due to the serious reasoning involved when thinking about the relation between and given real-life model and the concepts. Its application in both urban and rural locations give it the flexibility of urban and rural teacher using it to enhance the achievement of their students.

Recommendations

The study recommends the following:

1. Teachers of mathematics should use mathematical modelling method in teaching differentiation in the secondary school.
2. The government, Science Teachers Association and Mathematics Association of Nigeria should organize seminars and workshops to educate teachers on the best use of the method.
3. Teachers should endeavour to use real-life situations or models in the environment to demonstrate the concept whether in the rural or urban
4. Teachers should make sure male and female students collaborate when discussing the model(s) used in demonstrating the concepts

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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 (Iyekekpolor & 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 inform 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 device 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.

$Ho_{1;}$ 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.

$Ho_{2;}$ 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: Mean s and standard deviations of students taught mathematics using cooperative learning strategy and those taught using traditional lecture method?

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

Table1 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 Mean(X)	std.dev	Retention Mean(X)	std.dev	Mean diff
Cooperative	45	31.73	0.84	34.87	0.79	3.14

Table3 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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IMPACT OF PROCES-ORIENTED GUIDED INQUIRY LEARNING ON METACOGNITIVE SKILLS AND PERFORMANCE IN GEOMETRY AMONG SECONDARY STUDENTS IN KADUNA STATE, NIGERIA

Abstract

Purpose of the study was to examine the Impact of POGIL on Metacognitive Skills and Performance in Geometry among secondary school students in Kaduna state, Nigeria. Research hypotheses were formulated and tested at 5% levels of significance. The study population comprised of 62,072 public Senior Secondary (SS2). Quasi-experimental research design was used. Convenience sampling technique was used to select 131 students from two senior secondary schools. Two instruments namely: Geometry Performance Test (GPT) and Metacognitive Skills Inventory (MSI) were adapted, validated and used to collect data for the study. Descriptive statistics was to answer research questions. ANCOVA and PPMC were used to analysed null hypotheses. It was found that the mean of the experimental (55.29) was greater than the control group (39.12). This result shows that a difference exist in the performance mean of students. The finding shows that F (1,128) = 14.79, P = .000 between groups, P < .05. This means that null hypothesis Ho_1 was rejected. The result shows that ***a significant positive low correlation of r=.218, p=.012, p<0.05 exist between two dependent variables, metacognitive skills and performance.*** *Therefore, the Ho_2 is rejected. The finding revealed that F (3,126) = 10.702, P = .000 between groups, P < .05. This means that Ho_3 is rejected and H_α is retained. Hence there is significant impact on metacognitive skills and performance of students taught geometry using POGIL strategy. This result further revealed that using POGIL in teaching geometry is gender friendly. Based on the findings of this study, it was recommended that teachers should employ pedagogical approaches that encourage use of POGIL in teaching of Geometry in order to increase students' performance and metacognitive skills.*

Keywords: POGIL, Metacognitive, Performance and Geometry.

Introduction

Mathematics is a core subjects taught in Nigeria Secondary Schools. Effective delivery of mathematics instruction is no doubt of importance on secondary school students' learning and their performance. Mathematics is an essential ingredients and a basis for firm foundation of science and technological related professions. Mathematics as a tool to compute and conceptualize relationship among variables in science is an important tool in nation building. It can also be viewed as the pillar of all knowledge (Ayinla, 2011). To realize all these, our Mathematics Teachers need to employ effective and students' Centre strategies that would give learners the opportunities to explore the content themselves. The major concerns today are the consistently poor performance in mathematics among students especially at the secondary school level. Students' ability to apply mathematics in daily life is seen as a core goal of mathematics education (Graumann, 2011; Muller & Burkhardt, 2007; Niss et al., 2007). Indeed, it has been recommended that mathematics should be learned through problem-solving skills (National Council of Teachers of Mathematics, 2000). Academic performance can be defined as the level of an individual growth in a test when compared with the scores of others of the same level Achino (2002). Over the years the academic performance of senior secondary students in mathematics has been poor in both internal and external examinations. The chief examiner result for the WAEC (2017 to 2022) pointed out that some of the reasons for candidate poor performance in mathematics are student's inability to conceptualize the right strategies in solving problem on Geometry, poor understanding and interpretation of the Geometric problem and applying the correct theorem in order to arrive at right equation

before given final solution. In addition, in the WASSCE Chief Examiner's report (2017 to 2021), Students have been observed to have difficulty with Geometry (Circle Theorems). Mathematics in general has been seen as a difficult subject. Studies have shown that employing the right pedagogical strategies have positive effects on students learning and performance (Kajuru, 2006; Popoola, 2007; Yohanna, 2017).

Table 1 shows the trend of Students performance in Mathematics at SSCE level (WAEC) from 2017 to 2022 in Kaduna state. Table 1 captured the students' performance in WAEC May/June 2017-2022 in Kaduna state (NBS, 2022).

Table 1 : Students Performance in Mathematics in the West African Senior School Certificate Examination May/June 2017 – 2022

Year	Number of students who sat for exams	% of 5 Credits & Above Including Maths & English Lang	% Failure (Grades D7-F9)
2017	92 596	53.24	46.76
2018	81 312	40.73	59.27
2019	33 855	46.87	53.13
2020	34 449	49.51	50.49
2021	34 257	77.23	22.77
2022	1,222,505	76.36	23.64

(Source: National Bureau of Statistics, August, 2022; Educational Resource Centre, 2022)

From table 1, the students' performance from 2017 to 2022 in Kaduna state shows that there are concerns with the general performance in mathematics. It can be observed that the students' performance is not always above 50 percent in Kaduna state. The result in table 1 reveals a reasonable decrease in failure in 2021 results. In this regards, the numerous difficulties that students encounter with Geometry have promoted a number of suggested methods to improve delivery of instruction (Eastwood, 2013; Hein, 2012).

Geometry is considered to be one of the most fundamental and crucial area in mathematics, which plays a significant roles in developing various cognitive and problem-solving skills among students. However, the conventional teaching methods that focus on lecture-based instruction have been found to be inadequate in facilitating wider understanding of geometric concepts among secondary school students. As a result, there has been increasing focus on incorporating and implementing innovative and interactive pedagogical approaches that can improve the learning outcomes of students.

One such approach is the Process-Oriented Guided Inquiry Learning (POGIL) method, which is a student-centered and inquiry-based pedagogical approach that emphasizes active student engagement and collaboration. POGIL is based on the principles of constructivism, which posits that such a learning approach can enhance metacognitive skills and performance among students in various academic subject areas, including Geometry (Abbas et al., 2019; Fediuk et al., 2018; Rodriguez-Hoyos et al., 2019). Shadburn, Hess, and Finzer (2018) in a related study, found that POGIL significantly improved students' conceptual understanding of geometry and their ability to apply geometry concepts to real-world situations.

Similar studies on effects of POGIL-based

geometry instruction on metacognitive skills has been found to have significant impact on secondary school students learning and performance (e.g., Anderson et al., 2010; Jeong et al., 2020; Muis et al., 2013; Sun et al., 2018). In addition, Studies that employed pedagogical strategies different from the traditional lecture method were found to have positive effect on students learning and achievements on Geometry (Bitrus et al., 2020; Garba & Salim, 2020). Although there are differences among the models developed on basis of the inquiry learning approach all of the models are generally based on the first model of the learning cycle (Atkin & Karplus, 1962). This model which offers a general framework for organizing constructivist learning activities was developed using the theories of Piaget. The learning cycle has a tune-phase structure, namely; the exploration phase, the concept invention phase and the application phase (Karplus, 1977; Abraham & Remer, 1986). Students respond to questions included in activities in a peer-led guided inquiry learning environment is in cooperated in POGIL, where peer learning becomes prominent. Initially, relatively easily questions are organized in a way that enables student's alternative conceptions, misconceptions and inadequacies in terms of mental structures. Later on the questions become relatively difficult and are prepared in a way to ensure that the students acquire basic process skills (Moog & Spenser, 2008). The role teacher plays in POGIL is that of facilitator to students learning. They do not directly intervene in groups. They only become involved in group discussion when a group requests and then only to make sure that the scientific concepts are appropriately structured.

Metacognition was first coined by Flavell in 1970s to mean "thinking about thinking" (Flavell, 1979, P.906) subsequent development and use of the term have remained relatively faithful to this original meaning. That is, Metacognition refers to the ability to think about and reflect upon one's own thinking processes. POGIL encourages the development of metacognitive skills by enabling students to reflect on their reasoning, identify misconceptions and self-correct mistakes.

As such Geometry concept allow learners to think analytically and apply appropriate theorems in solving problems. For instance, researchers working in the field of cognitive psychology have offered the following definitions:

- The knowledge and control children have over their own thinking and learning activities. (Cross & Paris, 1988: 131).
- Awareness and management of one's own thought (Kuhn & Dean, 2004, P.270).
- Also seen as the monitoring and control of thoughts (Martines, 2006, P.696).

According to Kuhn and Dean (2004), metacognition is what enables a student who has been taught a particular problem context to retrieve and deploy that strategy in a similar but new context. Metacognition allows people to take charge of their own learning. It involves awareness of how they learn, and evaluation of their learning needs, generating strategies to meet these needs and then implementing the strategies (Hacker, 2009). Learners often show an increase in self-confidence when they build metacognitive skills. Self-efficacy improves motivation as well as learning success. Studies have shown that Process Oriented Guided Inquiry Learning (POGIL) on metacognitive awareness have positive impact on students learning outcomes (Gabel & Sherwood, 2015). Metacognitive skills are generally learned during a later stage of development. Metacognitive strategies can often (but not always) be stated by the individual who is using them. For all age groups, metacognitive knowledge is crucial for efficient independence learning because it fosters forethought and self-reflection. According to the theory, metacognition consists of two complementary processes, the knowledge of cognition and the regulation of cognition.

Gender means the

socially/culturally constructed characteristics and roles which are associated to males and females in any society (Okeke, 2007). On gender, there used to be low number of women in science related professions, but a significant progress has been attained in that regard. It has been observed that the attitude of girls toward mathematics in general is one factor that influences their lack of participation in science-related careers. This concern has resulted in a variety of studies designed to identify gender differences that could affect the number of girls in scientific (Oaks, 2000). Over the past three decades, a considerable number of studies seeking to determine a relationship between gender and mathematics learning have been conducted (e.g., Fierros, 1999; Zhang & Manon, 2000; Johnson, 200; Ericikan, McCreith, & Lapointe, 2005), the result in this studies showed that no significant differences exist in achievement between boys and girls in mathematics. Additionally, other studies that explored varied pedagogic strategies have found differences in academics achievements of male and female students. For instance, studies have shown that there is difference in mean scores of male and female students taught geometry using metacognitive approaches (Bitrus, et al., 2020; Essien & Ado, 2017).

Several studies have explored the efficacy of the POGIL approach on student learning outcomes in different subject areas. However, research on the impact of this approach on metacognitive skills and performance in Geometry among secondary school students is relatively limited in Kaduna state. Therefore, this study investigated the impact of POGIL on metacognitive skills and performance in Geometry among secondary school students. In Zaria Educational Zone Kaduna state Nigeria.

Theoretical framework

The study is theorized on constructivist instructional approach (CIA) which is in concordance with the guided inquiry based learning approach, attributed to constructivists. Peer learning theory of Piaget (1969) and social learning theory of Vygotsky (1978) the constructivism is a school of thought that believe in learners actively constructing their own knowledge and understanding using previous knowledge and interacting with instructional materials under the guidance of the teacher. Constructivism is a theory based on observation and scientific study about how people learn (Foxnot, 1996). It is said that people construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences. When we encounter something new, we have to reconcile with our previous ideas and maybe by changing what we believe, or by discarding the new information as irrelevant. In any case, learners are active creator of their own knowledge.

The theory of Piaget (1977) also suggested that through the process of assimilation and accommodation, individuals construct new knowledge from their experience into already existing framework without changing that framework. Piaget found that children needed to discuss their findings as well as having stimulating environment in which they can learn in pairs.

Based on this tenet of constructivism, the study examines the impact of POGIL on metacognitive skills and performance in Geometry among secondary school students in Zaria Educational Zone Kaduna state Nigeria.

The **objectives** of the study were to determine the performance of students taught Geometry using POGIL and to examine the metacognitive skills of students taught Geometry using POGIL.

Three **research questions** guided the study.

1. What is the impact of POGIL on students' meta-cognitive skills and performance in geometry?
2. What is the relationship between metacognitive skills and performance of students taught geometry using POGIL to those taught using lecture method?
3. What is the impact of POGIL on metacognitive skills and performance scores of male and female students in

geometry?

Research Hypotheses

The following null hypotheses were tested based on the research questions at 5% levels of significance.

HO_1: There is no significant impact of POGIL on students' meta-cognitive skills and performance in geometry

HO_2: There is no significance relationship between metacognitive skills and performance in geometry students taught using POGIL to those taught using lecture method.

HO_3: There is no significance impact on metacognitive skills and performance of male and female students taught geometry using POGIL

Methodology

The study employed a quasi-experimental design, with the control group (CG) receiving traditional lecture-based instruction, while the experimental group (EG) received POGIL-based instruction. Pretest was administered to the two groups, before the administration of treatment. The groups equivalence based on the ability of the students. The experimental group one students will be taught Geometry using POGIL as a method of teaching whereas the control group would be taught using the traditional lecture method of teaching.

The population of the study comprised of 62,072 public senior secondary two (SS2), students in Zaria Educational Zone, Kaduna State. Purposively, public schools were used because their organizational structure, condition of teaching and learning mode of operations are relatively the same. The study used a simple convenient sampling technique to select two senior secondary schools. This was achieved by writing the names of each school on piece of paper, folded and poured them inside a container. The total study sample consists of 131 students, which comprised of 62 male and 69 female students. This was in line with the central limit theorem which recommends a sample size of minimum of 30 subjects as proposed by Tuckman (1975). Two research instruments were adapted and used by the researcher in this study namely, Geometric Performance Test (GPT) and Metacognitive Skills Inventory (MSI). The Geometry Performance Test (GPT) consisted of 30 multiple choice items. The 30 items were adapted from WAEC past questions. The test items cover topics on plane Geometry and Circle Geometry. Each of the 30 multiple choice items had four options A - D, one correct answer and others three distracters. The time allocated for the 30 items was 45 minutes.

The Metacognitive Skills Inventory (MSI) was design to find out the students level of metacognitive awareness, reflection and thinking in Mathematics before and after treatment. The MSI was adapted from Schraw & Dennison (1994). It consisted of 30 items on self-report inventory. It was designed to determine statements representing three categories of metacognition: (knowledge of cognition and regulation of cognition, procedural knowledge and conditional knowledge). It was developed using 5 point Likert scale ranging from 5=Strongly Agreed, 4=Agree, 3=Undecided, 2=Disagreed and 1=Strongly Disagreed. The options are assigned numerical value of 5, 4,3,2,1. Students were asked to rate themselves freely on each item and a higher total score reflected greater metacognitive skills.

The instruments GPT and MSI were validated by three experts. These experts are from Science, and one from Mathematics departments and a psychometric expert, all from Ahmadu Bello University Zaria. The experts examined the items in terms of content, clarity and ambiguity of language used on items. They also certified if some items were inappropriate for the level of the students under the study and checked for possible errors and suggested corrections. The instruments GPT and MSI were pilot tested on a sample of 52 students selected from two senior secondary school two (SS2) in order to determine the appropriateness of the two instruments. The pilot testing also enables the researcher to determine the appropriate timing for each test as well as identify any problem

which may affect the effective administration of the instrument during the main research work.

The result of the pilot test was used to shows the reliability of the instruments as well as determined the analysis procedures of the test items. The reliability of the instrument GPT was determined through a test-retest using Pearson Product Moment Correlation while the reliability of MSI was determined using Cronbach Alpha Reliability Coefficient. From the result obtained, r-value of 0.84 was found indicating a strong positive relationship. While a Cronbach alpha coefficient of 0.85 of MSI was obtained to show that the two instruments were reliable. Thus, the instruments were reliable to measure the academic performance of the study and the metacognitive skills.

The Researcher was assisted by two research assistant from the sampled schools to conduct pre-test to both groups of students to determine their entry level and they were post-tested after they had undergone the treatment for six (6) weeks. The experimental group was taught Geometry using POGIL, while the control group was taught using the traditional Lecture Method. Each of the groups, experimental and control was taught for six weeks. At the end of the six weeks, the Geometric Performance Test (GPT) and Metacognitive Skills Inventory (MSI) were administered as a post-test to the students in the two groups. The data collected were analyzed using appropriate statistical tools. Research questions were answered using descriptive statistics while research hypotheses were tested using ANCOVA and PPMC respectively. The research hypotheses were tested at 0.05 levels of significance. Statistical Package for Social Science (SPSS) 20.0 version was used for data analyses

Results

Question one: What is the impact of POGIL on students' meta-cognitive skills and performance in geometry?

Table 2 : Descriptive statistics on the impact of POGIL on students' metacognitive skills and performance in Geometry

Metacognitive/ Perfoermance	N	Pre-Test Mean	STD	Post-Test Mean	STD
Exp. Group	62	37.87	12.44	55.29	19.06
Control Group	69	36.58	10.63	39.12	13.61

Table 2 shows that the pre-test metacognitive skills performance mean and standard deviation of the experimental group were 37.87 and 12.44 respectively and their post-test mean and standard deviation were 55.29 and 19.06 respectively. In the control group, the pre-test metacognitive skills and performance mean and standard deviation were 36.58 and 10.63 respectively, while their post-test metacognitive skills performance mean and standard deviation were 39.12 and 13.61 respectively. The metacognitive skills performance mean between the two groups shows that the pre-test has a difference of 1.13 while the mean difference in the post-test was 16.17. This shows that the use of POGIL strategy in teaching geometry has impact on metacognitive skills and performance students.

Research Question Two: What is the relationship between metacognitive skills and performance of students taught geometry using POGIL to those taught using lecture method?

Table 3 a and 3b : ANCOVA of pairwise comparisons between metacognitive skills and performance in geometry mean scores of student taught Geometry using POGIL and those taught using the traditional lecture method.

Variable	N	Metacognitive Skills Mean	Performance Mean
Experimental Group	62	45.58	55.29
Control Group	69	38.17	39.12

Table 3b. Pairwise Comparisons

Dependent Variable (i)group (j)group			Mean diff. (i-j)	Std. Error	Sig.
Performance	Exp. Post Test	Control Post Test	9.810*	2.959	.001
	Control Post Test	Exp. Post Test	-9.810*	2.959	.001
Metacognitive skills	Exp. Post Test	Control Post test	6.772*	1.866	.000
	Control Post Test	Exp. Post Test	-6.772*	1.866	.000

*The mean difference is significant at 0.05 level.

Tables 3a shows that the metacognitive skills mean of the experimental group (45.58) is higher than that of the control group (38.17). The result in table 3a also shows that the performance means of the experimental group (55.29) is greater than those of the control group (39.12). Hence, the result shows that students taught Geometry using POGIL have higher Metacognitive skills and performs better than those taught using the traditional lecture method.

Research Question Three: What is the impact of POGIL on metacognitive skills and performance of male and female students in geometry?

Table 4: Descriptive statistics on the impact of POGIL on students' metacognitive skills and performance in Geometry based on Gender

Metacognitive/ Perfoermance	N	Pre-Test Mean	STD	Post-Test Mean	STD
Male	30	41.75	14.25	55.47	18.95
Female	32	36.58	12.79	55.13	19.46

Table 4 reveals that the pre-test metacognitive skills performance mean and standard deviation of male of the experimental group were 41.75 and 14.25 respectively and their post-test mean and standard deviation were 55.47 and 18.95 respectively. While the female of the experimental group, has a pre-test metacognitive skills performance mean and standard deviation of 36.84 and 12.79 respectively. In addition, the post-test metacognitive skills performance mean and standard deviation of the female students were 55.13 and 19.46 respectively. The metacognitive skills performance mean between the two groups (male & female) students in the experimental group shows that the pre-test has a difference of 4.91 while the mean difference in the post-test was 0.34. This result shows that the use of POGIL strategy in teaching geometry has no gender bias on metacognitive skills and performance of students.

Hypotheses Testing

Ho_1: There is no significant impact of POGIL on students' meta-cognitive skills and performance in geometry

Table 5 ANCOVA (F -test) on the impact of POGIL on students' metacognitive skills and performance in geometry.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4835.225[a]	2	2417.613	10.816	.000
Intercept	17825.316	1	17825.316	79.748	.000
Prescore	1269.231	1	1269.231	5.678	.019
Groups	3306.050	1	3306.050	14.791	.000
Error	28610.790	128	223.522		
Total	358152.000	131			
Corrected Total	33446.015	130			

R Squared=.145(Adjusted R Squared =.131)

Table 5 shows that F (1,128) = 14.79, with P = .000 between the groups at P < .05. This means that the null hypothesis Ho_1, which says there is no significant impact of POGIL on students' meta-cognitive skills and performance in geometry compared to those taught geometry using the traditional lecture method. Hence there is significant impact on metacognitive skills and performance of students taught geometry using POGIL strategy

Ho_2: There is no significance relationship between metacognitive skills and performance in geometry students taught using POGIL to those taught using lecture method.

Table 6 : Pearson Product Moment Correlation coefficient is used to establish if relationship exist between the dependent variables.

Variable	N	Mean	Std Dev	Df	r-cal	p-value	Decision
Metacognitive skills	131	41.68	10.20	130	.218*	0.012	H_o rejected
Performance	131	46.77	18.25				

*Significant at 0.05

Table 6 reveals that a significant positive low correlation coefficient of r=.218, with p=.012, for p<0.05 exist between two dependent variables, metacognitive skills and performance. Therefore, the null hypothesis Ho_2 which states that: there is no significance relationship between metacognitive skills and performance in geometry students taught using POGIL to those taught using lecture method is rejected and the alternative hypothesis is retained. Hence, the result shows that students' awareness, reflections and critical thinking in their productions (metacognitive skills) are related to their performance in geometry.

Ho_3: There is no significance impact on the performance scores of male and female students taught geometry using POGIL

Table 7 : ANCOVA of the Impact of POGIL on students' Metacognitive skills and Performance in geometry based on Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	9602.809[a]	4	2400.702	8.977	.000
Intercept	17536.347	1	17536.347	65.573	.000
Prescore	643.673	1	643.673	2.407	.123
Groups	8585.802	3	2861.934	10.702	.000
Error	33696.321	126	267.431		
Total	329865.000	131			
Corrected Total	43299.130	130			

R Squared=.222(Adjusted R Squared =.197)

Table 7 shows that F (3,126) = 10.702, with P = .000 between the groups at P < .05. This result shows that the null hypothesis Ho_3, which stated that there is no significance impact on the performance scores of male and female students taught geometry using POGIL compared to those taught geometry using the traditional lecture method. Hence there is significant impact on metacognitive skills and performance of students taught geometry using POGIL strategy. Thus the null hypothesis is rejected and the alternative hypothesis is retained. This result further revealed that the employment of pedagogical strategy (POGIL) on metacognitive skills and performance of students in geometry is gender friendly.

Discussions

The result in Table 2 shows that the pre-test metacognitive skills performance mean and standard deviation of the experimental group were 37.87 and 12.44 respectively and their post-test mean and standard deviation were 55.29 and 19.06 respectively. In the control group, the pre-test metacognitive skills performance mean and standard deviation were 36.58 and 10.63 respectively, while their post-test metacognitive skills performance mean and standard deviation were 39.12 and 13.61 respectively. The metacognitive skills performance mean between the two groups shows that the pre-test has a difference of 1.13 while the mean difference in the post-test was 16.17. This shows that the use of POGIL strategy in teaching geometry has impact on metacognitive skills and performance students. Tables 3a shows that the metacognitive skills mean of the experimental group (45.58) is higher than that of the control group (38.17). The result in table 3a also shows that the performance means of the experimental group (55.29) is greater than those of the control group (39.12). Hence, the result shows that students taught Geometry using POGIL have higher Metacognitive skills and performs better than those taught using the traditional lecture method. This result are in line with the findings of (Muis et al., 2013) which found that students taught using POGIL had significantly higher metacognitive skills compared to those in the lecture method group. Similarly, the study is in line with findings by (Jeong et al., 2020) and that of (Shadburn et al., 2018) on POGIL-based geometry instruction showed significant improvements in their metacognitive skills. The study also agrees with the findings of (Sun et al., 2018) which revealed that students in the POGIL group achieved significantly higher scores in geometry assessments, indicating improved understanding and application of geometric concepts. The result in Table 4 reveals that the pre-test metacognitive skills performance mean and standard deviation of male of the experimental group were 41.75 and 14.25 respectively and their post-test mean and standard deviation were 55.47 and 18.95 respectively. While the female of the experimental group, has a pre-test

metacognitive skills performance mean and standard deviation of 36.84 and 12.79 respectively. In addition, the post-test metacognitive skills performance mean and standard deviation of the female students were 55.13 and 19.46 respectively. The metacognitive skills performance mean between the two groups (male & female) students in the experimental group shows that the pre-test has a difference of 4.91 while the mean difference in the post-test was 0.34. This result shows that the use of POGIL strategy in teaching geometry has no gender bias on metacognitive skills and performance of students.

The analysis of co-variance (ANCOVA) in Table 5 shows that F (1,128) = 14.79, with P = .000 between the groups at P < .05. This means that the null hypothesis Ho_1, which says there is no significant impact of POGIL on students' meta-cognitive skills and performance in geometry compared to those taught geometry using the traditional lecture method. Hence there is significant impact on metacognitive skills and performance of students taught geometry using POGIL strategy. **Table 6 reveals that a significant positive but low correlation coefficient of r=.218, with p=.012, for p<0.05 exist between two dependent variables, metacognitive skills and performance.** Therefore, the null hypothesis Ho_2 which states that: there is no significance relationship between metacognitive skills and performance in geometry students taught using POGIL to those taught using lecture method is rejected. Hence the alternative hypothesis is retained. Hence, the result shows that students' awareness, reflections and critical thinking in their productions (metacognitive skills) are related to their performance in geometry. The students taught using POGIL strategy demonstrated greater improvement in their metacognitive skills. Hence, the study is in line with the findings of (Anderson et al., 2010) that students who participated in POGIL had significantly higher scores on their geometry pre and post-tests than those who did not. Similarly, the result is in concordance with findings by Gabel and Sherwood (2015) and (Fediuk et al., 2018) that students who engaged in POGIL activities demonstrated increased metacognitive awareness and self-regulation. Table 7 shows that F (3,126) = 10.702, with P = .000 between the groups at P < .05. This means that the null hypothesis Ho_3, which stated that there is no significance impact on the performance scores of male and female students taught geometry using POGIL compared to those taught geometry using the traditional lecture method. Hence there is significant impact on metacognitive skills and performance of students taught geometry using POGIL strategy. Thus the null hypothesis is rejected and the alternative hypothesis is retained. This result further revealed that the employment of pedagogical strategy (POGIL) on metacognitive skills and performance of students in geometry is gender friendly. This result is in concordance with finding as those (e.g., Fierros, 1999; Zhang & Manon, 2000; Johnson, 200; Ericikan et al., 2005; Bitrus et al., 2020) show no significant differences exist in the achievement between boys and girls. Moreover, students who participated in POGIL had significantly higher scores in metacognitive awareness than those who did not.

Conclusions

The study concluded that teaching Geometry using POGIL have positive impact on the performance and metacognitive skills of students compared with those students taught same concept using the traditional lecture method. Moreover, the findings revealed insights into the effectiveness of POGIL in enhancing metacognitive skills and performance in Geometry among secondary school students. The implications of the results is for teaching practices, Curriculum developers, and Educational policy makers should focus more in promoting innovative and interactive pedagogical approaches that are relatively student Centre in the mathematics education programs.

Recommendations

The following recommendations are put forward by the researcher

1. Teachers are encouraged to use pedagogical strategies (POGIL) in the teaching of Geometric concept as to improve students' performance in Mathematics.
2. The use of POGIL in teaching to Geometry and mathematics at large should be encouraged in developing and increasing students metacognitive skills

It was suggested that more studies conducted on the effect of teachers' pedagogical approaches on the metacognitive skill and performance of student in Geometry. in Zaria educational zone of Kaduna state.

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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:1Increase in number of qualified mathematics teachers in the educational systems by encouraging students to study Mathematics Education at the College and in the University 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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