EFFECT OF GEOGEBRA APPLICATION ON ACADEMIC ACHIEVEMENT AND INTEREST OF JUNIOR SECONDARY SCHOOL STUDENTS IN MATHEMATICS IN AKWA IBOM STATE, NIGERIA

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Abstract
The study investigated the effect of GeoGebra application on academic achievement and interest of junior secondary students in Mathematics in Akwa Ibom State, Nigeria. The research questions guided the study and two null hypotheses were tested at 0.05 level of significance. The study adopted a pretest, posttest quasi experimental design. The population consisted of 13,157 junior secondary two (JS2) Students made up of 5,876 males and 7,281 females. Two schools were purposively sampled and simple random sampling technique (toss of coin) were used in selecting two intact classes of junior secondary two (JS2) Students of 2021/2022 academic session for experimental and control groups. Two validated instruments Mathematics Achievement Test (MAT) and Mathematics Interest Scale (MIS)were used for the data collection in the study. Kuder-Richardson Twenty (K-R)$_{20}$ formula was used to determine the reliability coefficient of 0.85. The research questions were answered by descriptive statistics; mean and standard deviation while the hypotheses were tested using Analysis of Covariance (ANCOVA) statistic at $p < 0.05$ level of significance. The findings revealed a significant difference between the achievement of the experimental group and control group in favour of the experimental group. The result also showed that the use of GeoGebra enhanced greater motivation and positive attitude towards mathematics. Based on the findings, it was recommended that Mathematics teachers should intensively employ the use of Mathematical software such as GeoGebra that will actively involve both the teachers and students during teaching learning processes.
Keywords: GeoGebra, Achievement, Interest, Geometry, Mathematics

Introduction

Mathematics, coined from the Greek word or language "Mathema" meaning "knowledge, study or learning" is the study of areas such as quantity (numbers), structure, space and change. Mathematics is a way of describing relationships between number and other measurable quantities. Azuka (2013) sees Mathematics as not only language of the science, but an important nutrient for thought, logic, reasoning and progress. Some of its main sub-

divisions are arithmetic, algebra, geometry, trigonometry and calculus. Kajuru (2006) observed that since the beginning of recorded history, Mathematics discovery has been at the forefront of every civilized society. He further emphasized that the need for Mathematics arose based on the wants of the society, the more complex a society, the more complex the Mathematical needs. Thus, every nation needs mathematics.

Various nations across the world are classified as first – world, second – world or third – world on the basis of each nation's level of development in Science and Technology, which are power-driven by refined numerical manipulation that always employ Mathematics as its basic tool. The central position of Mathematics to national development has resulted in education policy makers resolving to position Mathematics as a required subject for admissions and even employment purposes (Kolawole, 2013). Odili(2002) explains that Mathematics is the bedrock of many professional courses. Mathematics is accepted in the present world of science and technology as the "queen of science and the language of nature" and no nation can hope to achieve any measure of scientific and technological advancement without foundation in mathematics (Uko, 2016). For this reason, the researcher ventured into innovative teaching approach through the use of GeoGebra strategy to investigate the extent it will reduce the problem associated with learning mathematics among junior secondary school students.

GeoGebra is a mathematics software that learners operate and navigate to represent a variety of conceptual relationships to real life situation (Kalu, 2015). GeoGebra is one form of instructional material that offers unique opportunities for learners to build and communicate mathematical ideas. Markus (2008) defined GeoGebra as dynamic mathematics software used for teaching and learning of mathematics in schools which includes: geometry, algebra, and calculus. However, GeoGebra is an interactive geometry system. Through the use of GeoGebra, one can carry out constructions with points, vectors, segments, lines, and conic sections as well as functions while changing them dynamically afterwards. Consequently, equations and coordinates can be entered directly. Thus, GeoGebra has the ability to deal with variables for numbers, vectors, and points. It finds derivatives and integrals of functions and offers commands like Root or Vertex. There are two characteristic of GeoGebra: an expression in the algebra window that corresponds to an object in the geometry window and vice versa.

For the purpose of this study, the researcher defines GeoGebra as a software representation of mathematical concept that can be seen and navigated about by both teachers and learners to aid them validate and explain their mathematical ideas and for the purpose of making mathematics enjoyable, effective and interesting in order to enhance teaching and learning of mathematics. GeoGebra was invented by Markus Hohenwarter and Julius Hohenwarter in the year 2008. GeoGebra was created as a free, open-source dynamic mathematics software, which is used for both teaching and learning mathematics from middle school through college to the University level (Hohenwarter & Preiner, 2008). GeoGebra offers geometry, algebra and calculus features in a fully linked, compressed and easy-to-use software environment. In other words, this device spreads the concepts of dynamic geometry to the fields of algebra and mathematical analysis. GeoGebra is designed specifically for educational purposes, which can help learners grasp experimental,

problem-oriented and research-oriented learning of mathematics, both in the classroom and at home. Students can simultaneously use a computer algebra system and an interactive geometric system to increase their cognitive abilities in the best way.

GeoGebra in this usage is such a device that the teacher will use to present mathematical concepts to the learners in the software form in order to make visualization and understanding very clear and real. The West African Examination Council (WAEC) and National Examination Council of Nigeria (NECO) Chief Examiner's report between 2020 and 2022 has consistently drawn attention to poor achievement of students in certain mathematics topics at the senior Secondary certificate Examination. Such areas of weakness include: Mensuration, trigonometry, geometry and statistics. However, research studies attributed the poor achievement of students in examinations mostly to the teaching approach adopted by mathematics teachers in presenting instructions (Ogbonna, 2004). Explaining further, Ogbonna lamented that even students who are capable of demonstrating success, who pass tests with high marks and obtain "honours", diplomas, frequently do not connect the information they receive in school to interpretations of the world around them. This is attributed to the method of teaching (conventional teaching method) adopted by most mathematics teachers. The teaching and learning of mathematical concepts especially in geometry at secondary level of education still remain a serious problem due to the abstract nature of the concepts.

Geometry is a branch of Mathematics concerned with shape, size, relative position of figures and the properties of space. In particular, geometry has come to play great roles in science. For example in Physics, it is used in the study of relativity. Geometric ideas are a2lso of great importance to engineering, surveying, geologist and navigation (Obilor, 2020). According to Obilor, the relevance of Geometry in life has awarded it a central place in mathematics curriculum. It has become the pivot on which main scientific and technological innovations center. It helps a learner in the development of aesthetics around his environment as well as inductive reasoning skills and is taught in schools right from primary level to tertiary level (Yosoff, 2013). Geometry is the branch of mathematics in which visualization is one of the most essential elements for understanding definitions and theorems, as well as solving the given tasks and problems. According to Steven in Prakash (2013), early advancement of Babylonians and Egyptians used geometrical concepts in their everyday lives to do many things like building structures such as the pyramids, plot square corners of fields and so on. Owing to the aforementioned, it is obvious that the importance of geometry in everyday life cannot be over emphasized. It is because of this importance that Geometry is included as one of the core topics in primary and secondary school mathematics.

However, geometry is one of the mathematical concepts that mostly require instructional materials like GeoGebra for its teaching and learning at all level of education. Teaching of geometry with GeoGebra at all education levels can help in understanding the basic facts such as angles, shapes, lines, line segments, curves in geometric figures (plane and solid shapes) and can also help in understanding the basic facts about geometric transformation such as reflection, rotation and translation. The implication is that, for geometry to be effectively communicated there is need to apply teaching aids that will

assist the teacher in making connection between its abstract nature and real life applications. When the learners use and interact with GeoGebra and interact with one another, learning can become interesting and achievement improved (Hohenwarter & Preiner, 2008).

Achievement means to reach a required standard of performance, or to carry out a task successfully. In the context of this study, achievement refers to reasoning progress of students in terms of passes gotten from teacher-made test/standardized test in mathematics. Hence, the researcher upholds the view that, students' Academic achievement entails successful academic progress attained through effort and skill (Ajai, 2015). It involves the determination of the degree of performance and attainment of individuals in tasks, courses or programmes to which the individuals were sufficiently exposed. The academic achievement of secondary school students in mathematics has not been encouraging (Alio and Okafor, 2018). Teaching with mathematics software such as GeoGebra helps the teacher to employ variety of strategies and approaches to meet learning needs of learner, whereby students have equal opportunities to learn irrespective of their abilities, location or gender. For mathematics achievement to be awakened in students, they must have interest in the subject which is worth exploring.

Interest according to Imoko and Agwagah (2006) is a personal feeling of attention or persisting tendency to pay attention and enjoy some activities or content. Obodo in Alio and Okafor (2018) opined that it is the feeling of intentness, concern or curiosity about an object. Interest refers to the condition of being eager to know or learn about something. It is an important variable in the teaching and learning of mathematics. This is because when a student becomes interested in an activity, they are likely to be more totally involved in that activity. Okigbo and Okeke (2011) stated that, "a student may be intellectually and physically capable to learn, he/she may never learn until his/her interest is stimulated". Once the interests of students are stimulated, they will continue to learn as long as their teacher is capable of sustaining their interest in the subject matter. Okigbo and Okeke further states that interest is a mother to attention, and once there is direct interest, attention is guaranteed and learning is assured. Psychological disposition like interest could be a factor in determining the relative interest of the students, the role of interest in the learning process has been x-rayed by Okorie (2016) when he noted that the zeal with which students enters into any learning activity is in order of their interest in the particular activity. Students appear to learn more effectively those things that appear to interest them. Mamman and Isa (2018) recommended that interest –boosting activities such as use of models during lessons, formation of discussion groups, use of appropriate innovative methods and strategies be adopted in the mathematics classrooms.

Though interest may influence students' achievement in Mathematics, type of exposure and many other variables may also influence students' achievement in Mathematics. Hence, it is in the light of this that the researchers decided to investigate the effect of GeoGebra Application on Mathematics Students' Academic Achievement and interest in AkwaIbom State.

Purpose of the study

The purpose of this study was to investigate the effect of geogebra application on academic achievement and interest of junior secondary school students in mathematics in Akwa Ibom State, Nigeria. Specifically, the study sought to determine:

1. the mean achievement scores of students taught mathematics using GeoGebra application and those taught using conventional method?
2. the mean interest scores of students taught mathematics using GeoGebra application and those taught using conventional method

Research Questions

The following research questions were posed to give direction to the study:

1. What are the mean achievement scores of students taught mathematics using GeoGebra application and those taught using conventional method?
2. What are the mean interest scores of students taught mathematics using GeoGebra application and those taught using conventional method?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance

1. There is no significant difference in the mean achievement scores of students taught mathematics using GeoGebra application and those taught using conventional method.
2. There is no significant difference in the mean interest scores of students taught mathematics using GeoGebra application and those taught using conventional method.

Method

This study adopted quasi-experimental research design. Specifically; a pre-test and post-test design was used for the study. The design is considered appropriate because the researcher used intact classes as experimental and control groups respectively. The use of intact classes is to ensure none alteration of regular class periods since secondary school authority in AkwaIbom State does not allow their lesson periods to be altered. The experimental group was taught geometry using GeoGebra and the topics taught are: properties of plane shapes, perimeter of plane shapes and area of plane shapes. On the other hand, the control group was taught the same topics without using GeoGebra. The area of the study was AkwaIbom state. AkwaIbom is a state in Nigeria. The population of the study was thirteen thousand, one hundred and fifty seven (13,157) Junior Secondary Two Students (JS2) in AkwaIbom State Public Secondary Schools in 2018/2019 academic session. This population figure of 13,157 JSS2 Students consists of five thousand eight hundred and seventy six (5,876) male Students and seven thousand two hundred and eighty one (7,281) female students. The sample for this study was 104 JSS2 Students in intact classes of Junior Secondary Two (JS2) 2021/2022 academic session purposively drawn from two public secondary school in Uyo Local Government Area of AkwaIbom State. The researcher adopted simple random sampling technique to select the intact classes for

experimental group and the one for control group respectively. These schools were selected because they are better equipped with ICT facilities than other schools in the area. Two instruments, namely; Mathematics Achievement Test (MAT) and Mathematics Interest scale (MIS) were used for data collection in the study.

The following procedures were used in order to ascertain the face and content validity of the research instruments. The Mathematics Achievement Test and Mathematics Interest scale were given out for validation to three (3) Lecturers, One from science Education Department in University of Uyo, Uyo and two from Michael Okpara University of Agriculture, Umudike; one from Mathematics Education and one from Measurement and Evaluation at Michael Okpara University of Agriculture, Umudike for critical assessment and suitability of the test questions. Their comments and corrections were used as directed before the production of the final copies of the instruments.

To obtain the reliability of the instruments, a trial testing was carried out. Twenty four (24) Junior Secondary two (JS2) students from Co – Science Secondary School in Uyo, which is within the Education Zone of the study were used for trial testing of the instruments. Thereafter, Kuder-Richardson Twenty $(K\text{-}R)_{20}$ formula was used to determine the reliability coefficient of 0.85. The Kuder-Richardson Formula Twenty ($K\text{-}R_{20}$) was used because responses to the MAT and MIS entailed right or wrong answers, that is, they are dichotomously scored.

The Mathematics Achievement Test (MAT) items were developed based on the behavioural objectives pre-stated to be achieved at the end of the lessons. From the sub-topics forty (40) multiple choice questions were constructed. The forty (40) multiple choice questions have four (4) options (A-D) and each correctly answered question was scored 1 mark, while an incorrect answer attracted zero mark. Thus, answering all the questions correctly gave a total 40 marks.

The second instrument is the Mathematics Interest Scale (MIS) that contained 20 items structured to find out the students' interest in learning mathematics. The interest scale modified was structured on a four-point likert scale of Strongly Agree (SA) (4-points), Agree (A) (3-points), Disagree (D) (2-points) and Strongly Disagree (SD) (1-point). The negative statements was scored in the reverse format i.e Strongly Agree (SA) (1-point), Agree (A) (2-points), Disagree (D) (3-points) and Strongly Disagree (SD) (4-points).

The study lasted for six weeks; first week was for pre-test (administration of the instrument to both experimental and control groups), while the actual treatment for both the experimental and control groups lasted for four weeks. The last week was used for re-administration of the 40 items MAT test items (post-test) and 20 items in Mathematics Interest Scale.

Mean and standard deviation were used in answering the research questions and analysis of Covariance (ANCOVA) was used in testing the hypotheses at alpha level of 0.05

Results

Research Question One

What are the mean achievement scores of students taught mathematics using GeoGebra application and those taught using conventional method?

Table 1: The mean achievement scores of Students taught mathematics using GeoGebra and those taught using conventional method.

Variables	N	Pre-Test Mean	SD of Pre-Test	Post-Test Mean	SD of Post-Test	Difference in Mean
Experimental Group	54	27.04	2.36	53.45	5.45	26.41
Control Group	50	33.87	3.10	41.91	3.59	8.04

Table 1 shows that the pre-test and post-test mean achievement scores of Students taught with GeoGebra are 27.04 and 53.45 respectively with a difference mean score of 26.41. This indicates that learning actually took place. Furthermore, the table also presented the pre-test and post-test mean achievement scores of Students taught mathematics using Lecture method as 33.87 and 41.91 with mean difference of 8.04. The pre-test mean achievement scores of the two groups (27.04 and 33.87) revealed that the Students from control group appeared to have higher level of knowledge on what they were to learn than the Students from the Experimental group before the experiment took place. The mean achievement score (post-tests) of Students taught mathematics with GeoGebra were higher than the mean achievement scores of Students taught mathematics using conventional method (53.45 and 41.91).

Hypothesis One

There is no significant difference in the mean achievement scores of students taught mathematics using GeoGebra and those taught using conventional method.

Table 2: Analysis of covariance on the mean achievement scores of Students taught using GeoGebra and those taught using conventional method.

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1222.825[a]	2	611.413	78.749	.000	.607
Intercept	1998.969	1	1998.969	257.463	.000	.913
PRETEST	.092	1	.092	.012	.000	.319
Groups	1033.188	1	1033.188	133.073	.000	.570
Error	791.937	101	7.764			
Total	100455.000	104				
Corrected Total	2014.762	103				

a. R Squared = .607 (Adjusted R Squared = .599)

Table 2 shows that the F-ratio is 133.073 with 1 degree of freedom. However, since the associated alpha level of .000 is less than the p-value of 0.05 ($p > 0.05$), the null hypothesis which states that there is no significant difference in the mean achievement scores of students when taught mathematics using GeoGebra and when taught using conventional method is not accepted. This implies that there is a significant difference in the mean achievement scores of Students taught mathematics using GeoGebra and those taught using conventional method.

Research Question Two

What are the mean interest scores of students taught mathematics using GeoGebra application and those taught using conventional method?

Table 3: The mean interest scores of Students taught mathematics using GeoGebra and those taught using conventional method.

Variables	n	Pre-Test Mean	SD of Pre-Test	Post-Test Mean	SD of Post-Test	Difference in Mean
Experimental Group	54	47.80	3.44	66.98	7.20	19.16
Control Group	50	46.98	2.83	56.92	5.32	9.94

Table 3 shows that the pre-test and post-test mean interest scores of Students taught with GeoGebra are 47.80 and 66.98 respectively with a difference mean interest scores of 19.16. This indicates that Students' interest was enhanced. Furthermore, the table also presented the pre-test and post-test mean interest scores of Students taught mathematics using conventional method as 46.98 and 56.92 with mean difference of 9.94. The pre-test mean interest scores of the two groups (47.80 and 46.98) revealed that the Students from Experimental group appeared to have greater interest level towards mathematics than that of the Control group before the experiment took place. The mean interest scores (post-tests) of Students taught Mathematics with GeoGebra were higher than the mean interest scores of Students taught Mathematics using conventional method (66.98 and 56.92).

Hypothesis Two

There is no significant difference in the mean interest scores of students when taught mathematics using GeoGebra and when taught using conventional method.

Table 4: Analysis of covariance on the mean interest scores of Students taught mathematics using GeoGebra and those taught using conventional method.

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	10035.504[a]	2	5017.752	530.892	.000	.912
Intercept	1785.826	1	1785.826	188.945	.000	.952
PRETEST	398.923	1	398.923	42.207	.000	.391
Groups	1539.743	1	1539.743	162.909	.000	.821
Error	964.058	101	9.452			

Total	362366.000	104
Corrected Total	10999.562	103

a. R Squared = .912 (Adjusted R Squared = .911)

Data in table 4 shows that the F-ratio is 162.909 with 1 degree of freedom. However, since the associated alpha level of .000 is less than the p-value of 0.05 ($p > 0.05$), the null hypothesis which states that there is no significant difference in the mean interest scores of students when taught mathematics using GeoGebra and when taught using conventional method is not accepted. This implies that there is a significant difference in the mean interest scores of Students taught mathematics using GeoGebra and those taught using conventional method.

Discussion

Result from the tables showed that Students who were taught using GeoGebra performed significantly better than those taught using conventional method. This study is in tandem with Uko (2016), which discovered that GeoGebra improves students' performance in mathematics more than ordinary conventional method. This implies that getting learners involved through the use of GeoGebra encourages learners to actively participate in teaching and learning of mathematics. This study is in support of Nanang (2017) who in his study stated that the use of GeoGebra in teaching during mathematics lessons is better than the conventional method at improving Mathematical Representation Ability by students' performance in geometrical construction. The finding made an emphatic premise which gave support to what was earlier stated by Pellumb (2010), that GeoGebra software is a tool and a platform that can be used by the students of any level. It can be used by the young people, even by the students of the primary school. This is because of the great number of varieties of the exercises and of different types like puzzle and entertaining, construction, testing, research, problem-solving and so on, that can be accomplished by using GeoGebra tools and its platform. Young people are game-driven and curiosity problem-driven. GeoGebra software is the right tool and the platform meeting the trends and the needs of this generation not only in the school but in their homes as well or elsewhere, suffice to have internet access. GeoGebra is an open source for teaching and learning, free of charge and for all. The outcome of the findings is instructive to teachers, Students, administrators and government. It implies that instructional materials like GeoGebra among others should be made available by government, school administrators and teachers during teaching of mathematical concepts to improve level of understanding mathematical concepts by students. This will in turn reduce poor achievement in mathematics especially at junior secondary school level of education.

The results of table 3 and 4 showed that Students who were taught using GeoGebra had higher mean interest scores than those taught using conventional method in mathematic. This could be as a result of contributory factor of hands-on instructional

approach in using GeoGebra in learning mathematical concepts. This is because some researchers have found that when one becomes interested in an activity, one is likely to be more deeply involved in that activity (Okigbo and Okeke, 2011).This finding is in conformity with Dogan (2010), who's work found that the use of GeoGebra Software in teaching increased higher thinking skills among learners of Mathematics. The software was also observed as having a positive effect in motivating students towards learning and retaining their interest and knowledge for a longer period. The result of the findings concurs with Yusuf (2016) who identified dynamic software (Geometer's Sketchpad) as one of the influential Mathematical Software in the teaching and learning of mathematics. According to Yusuf, the dynamic software had a positive effect on students' achievement and interest towards learning of graph functions. The recent findings means that, school administrators and teachers who are in constant search for lasting solution to persistent poor achievement and interest of pupils in mathematics, should pay more attention in use of instructional materials, especially those that give students participatory opportunity during teaching and learning of mathematical concepts. There is therefore need for teachers to shift from conventional approach of teaching where talk and chalk method are used in teaching mathematical concept, to other approaches like using Mathematical Software like GeoGebra that gives students participatory opportunity during teaching and learning of mathematical concepts. This will go a long way in providing solution to poor academic achievement and interest of students' in teaching and learning of mathematics.

Conclusion

The study was carried out in Uyo Education Zone of Akwa Ibom State. The results of the study showed that the use of GeoGebra in teaching mathematics to Junior secondary school Students improved their achievement and interest in mathematics. The result also showed that the use of GeoGebra enhanced greater motivation and positive attitude towards mathematics which led to improved achievement and interest.

Recommendations

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

1. Mathematics teachers should intensively employ the use of Mathematical software such as GeoGebra that will actively involve both the teachers and students during teaching learning process. This will provide participatory opportunity for Students to interact with the objects and one another to enhance Students' understanding, and achievement in mathematics.
2. To ensure that teachers of Mathematics are equipped with the usage of GeoGebra Software. Mathematics teachers should be trained on the use of GeoGebra Software during their training process by the teacher educators.
3. Ministry of Education policy makers should organize seminars, workshops and conferences on the use of computer-based instructional package such as GeoGebra for serving teachers, teacher educators, textbook writers and curriculum developers.
4. Curriculum splaners should incorporate the use of GeoGebra instructional package in restructuring Mathematics curriculum in Nigeria.

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