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Influence of GeoGebra on Interest of Junior Secondary School Students in Mathematics in Akwa Ibom State, Nigeria

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ABSTRACT

The study investigated the influence of GeoGebra application on interest of junior secondary students in Mathematics in Akwa Ibom State, Nigeria. 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) was used in selecting two intact classes of Junior Secondary two students of 2018/2019 academic session for experimental and control groups. The research was guided by two research questions and two hypotheses. one validated instruments of Mathematics Interest Scale with reliability coefficient of 0.85 was used for data collection. 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 interest of the experimental group and control group in favour of the experimental group. It also revealed that the use of GeoGebra is clearly independent of gender. Based on the result of the findings,it was recommended that Curriculum planers should incorporate the use of GeoGebra instructional package in restructuring Mathematics curriculum in Nigeria.

Key words: GeoGebra, interest, gender, 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, it is 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).

Though Mathematics is very important and compulsory for every citizen in the nation, students' performance in Mathematics (in both internal and external examinations) have remained consistently poor and not satisfactory (Nwadiae, 2010). This indescribable level of poor performance in Mathematics across all levels of educational echelon has continued to be an issue of enormous concern to stakeholders in education enterprise including educational administrators, researchers, teachers, parents and even students. In Nigeria, there are ample evidences of continued poor interest of students in both standardized and teacher made examinations (Ado & UmoAbasi, 2014). Eshiet (2012) observed that Mathematics offered the highest difficulties to students among the science subjects in the West African School Certificate Examinations in the previous decade. Some researchers have seen the situation to be as a result of teachers' negligence of discovering the problem-solving strategies as substitute strategy to replace the conventional method of teaching mathematics which has failed to yield reasonable positive results in terms of students' interest (Alio, 2012, Udousoro, 2009, 2011). 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 characteristics 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 2009 and 2017 have consistently drawn attention to poor interest 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 interest 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 also 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 a mathematical concept that requires instructional materials like GeoGebra for its teaching and learning at all level of education. Teaching of geometry with GeoGebra at all education levels help in understanding the basic facts such as angles, shapes, lines, line segments, curves in geometric figures (plane and solid shapes). GeoGebra also help in understanding the basic facts about geometric transformation such as reflection, rotation and translation. The implication is that, 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 interact with GeoGebra and interact with one another, learning become interesting and interest improved.

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) said that it is the feeling of intentness, concern or curiosity about an object. Interest refers to as 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, pg 34) have this to say, "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. The Okigbo and Okeke also said 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 enter 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.

Gender is a complex and dynamic force that affects every social interaction, including interactions in educational settings. Its effects are woven into educational outcomes, and at times contribute to complicated disparities, specifically in the field of mathematics education. Much studies have been carried out on the possible sources of these fascinating gender issues. Hamza and Timayi (2018) threw more light on gender issues in mathematics. Some of Hamza and Timayi studies analyzed the gender differences in relation to results attained on performance tests, while others have focused on more specific topics, such as spatial visualization, the differential relations that mathematics teachers may establish with female and male students at various educational levels, the distinct attitudes of girls and boys towards mathematics and

towards the use of instructional materials as an aid in teaching and learning mathematics. Though gender may influence students' interest in Mathematics, type of exposure and many other variables may also influence students' interest in Mathematics. Hence, it is in the light of this that the researcher decided to investigate the effectiveness of GeoGebra Application on Mathematics Students' Interest in Akwa Ibom State.

Research Questions

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

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

Hypotheses

The following null hypotheses were postulated at 0.05 level of significance to guide the study.

$H0_1$: There is no significant difference in the mean interest scores of students when taught mathematics using GeoGebra and when taught using conventional method.

$H0_2$: There is no significant difference in the mean interest scores of male and female students taught mathematics using GeoGebra application.

METHODOLOGY

The 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 Akwa Ibom 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 Akwa Ibom state. Akwa Ibom is a state in Nigeria.The population of the study was 13,157 Junior Secondary Two Students (JS2) in Akwa Ibom State Public Secondary Schools in 2018/2019 academic section. The population consists of 5,876 male 7,281 female students. The sample for this study is 104 JSS2 Students in intact classes purposively drawn from two public secondary school in Uyo Local Government Area of Akwa Ibom State. The researcher adopted simple random sampling technique to select the intact classes for experimental and control groups respectively. These schools were selected because they are better equipped with ICT facilities than other schools in the area. The researchers considered gender and included co – educational secondary schools where boys and girls study together under the same learning environment in the study.

One instrument namely 'Mathematics Interest Scale' was used for the study. The Mathematics Interest Scale (MIS) 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 were 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 20 items MIS items (post-test)

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 1

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

Table 1

The mean interest scores of Students taught mathematics using GeoGebra and those taught using conventional method

Variables	N	Pre-Test Mean	Pre-Test SD	Post-Test Mean	Post-Test SD	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 1 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 score 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).

Research Question 2

What are the mean interest scores of male and female students taught mathematics using GeoGebra application?

Table 2

The mean interest scores of male and female Students taught mathematics using GeoGebra.

Gender	N	Pre-Test Mean Scores	Post-Test Mean Scores	Difference in Mean
Male	25	48.28	67.83	19.55
Female	29	45.78	65.54	19.02
Difference		**2.50**	**2.92**	

Table 2 shows the difference that exist in the pre-test and post-test mean interest scores of male and female Students taught mathematics using GeoGebra. The pre-test and post-test mean interest scores of the male Students are 48.28 and 67.83 respectively with mean difference of 19.55 which showed an increase in interest. While that of the female Students are 45.78 and 65.54 respectively with a difference of 19.02 which also showed an increase in interest. However, the difference in male and female pre-test mean interest scores tend to suggest that the two groups do not differ much in their interest towards learning of mathematics before treatment, while slight difference in the post test mean interest score tend to suggest that the male Students had slight interest more than the female Students taught mathematics using GeoGebra.

Hypothesis 1

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

Table 3

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)

Table 3 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.

Hypothesis 2

There is no significant difference in the mean interest scores of male and female students taught mathematics using GeoGebra application.

Table 4

Analysis of covariance on the mean interest scores of male and female Students taught mathematics using GeoGebra

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5214.081[a]	2	2607.040	689.008	.000	.964
Intercept	349.242	1	349.242	92.300	.000	.986
PRETEST	.451	1	.451	.119	.731	.315
Gender	363.407	1	363.407	96.044	.000	.846
Error	196.756	51	3.784			
Total	196512.000	54				
Corrected Total	5410.836	53				

a. R Squared = .964 (Adjusted R Squared = .962)

Data in table 4 shows that the F-ratio is 96.044 with 1 degree of freedom and 0.000 significant level. Since the associated alpha level 0.000 is less than the p-value of 0.05 ($p>0.05$), the null hypothesis that there is no significant difference in the mean interest scores of male and female students taught mathematics using GeoGebra application is not accepted. This implies that there is a significant difference in the mean interest scores of male and female Students taught mathematics using GeoGebra.

DISCUSSION OF FINDINGS

The results from the study 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 hands-on instructional approach in using GeoGebra in learning mathematical concepts. This is consistent with research findings that when one becomes interested in an activity, one is likely to be more deeply involved in that activity (Okigbo & Okeke, 2011). The 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 results from Tables 2 and 4 showed that there was significant difference in interest means score of male and female Students taught mathematics using GeoGebra. The result of this study is in line with the work of Prendergast (2011) and Lazarides and Ittel (2012), who asserted that interest has a powerful influence on academic

performance and they demonstrated the function of fostering, remembering and understanding material and stimulating students' positive attitude towards a topic. Interest has a profound effect on students' recollection and retrieval processes, their acquisition of knowledge, and their effort expenditure. The result of the findings is also in line with Okigbo and Okeke (2011) who posited that, interest is an important variable in learning because when one becomes interested in an activity, one is likely to be more deeply involved in that activity. The result clearly shows that good Mathematical Software can stimulate and sustain learners' interest irrespective of their gender in mathematics. These outcomes are in consonance with some researcher findings on effect of gender on Students' interest which showed significant effect on the interest of male and female Students in mathematics (Kolawale & Ogini, 2009; Iji, Abakpa & Takor, 2013).

CONCLUSION

This study investigated the impact of GeoGebra application on Mathematics Students' academic Interest in Uyo Education Zone. Two research questions and two hypotheses were formulated to guide the study. The results of the study showed that the use of GeoGebra in teaching mathematics to Junior secondary school Students improved their interest in mathematics. The result also showed that the use of GeoGebra enhanced greater motivation and positive attitude towards mathematics which led to improved interest.

RECOMMENDATION

Based on the result of 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 which will provide participatory opportunity for Students to interact with the objects and one another to enhance Students' understanding, and interest 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 planers should incorporate the use of GeoGebra instructional package in restructuring Mathematics curriculum in Nigeria. The curriculum should be restructured to reflect the basic concept of GeoGebra instructional package as they pertained to Mathematics teaching/learning.

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