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Effect of GeoTAN Instructional Software Package on Secondary School Students' Achievement in Geometry

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Abstract

This study set out to ascertain the effect of Geotan Instructional Software Package (GISP) on Secondary School students' achievement in geometry and to determine the influence of gender on the achievement students' scores in geometry. Two research question guided the study while three hypotheses were formulated and tested at 0.05 levels of significance. Using quasi-experimental (non-equivalent control group) design, with a sample of 240 drawn from a population of 33,074 Senior Secondary School year two (SSS2) students in public secondary schools, data were collected, using three validated instruments: Geometry Achievement Test (GAT), with a reliability index of 0.87 determined using K-R 20 method; GISP and Lesson Plan Geometry (LPG), with content validity index of 0. 82, determined using Kendall's W method. GISP and LPG were used as instructional tools. Mean and standard deviation were used to answer the research questions; Two-way Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Data analysis gave the following Results: Method of teaching has significant effect on students' mean achievement in geometry $F(1, 235) = 521.271$, $P < 0.0005$; gender has no significant influence on students' achievement in geometry $F(1, 235) = 1.584$, $P = 0.209$ and the interaction effect of method and gender on students' achievement score in geometry is not significant $F(1, 235) = 2.035$, $P = 0.155$. Based on the findings, recommendations were made: to improve teaching and learning of geometry in senior secondary school.

Keywords: GeoTAN Instructional Software Package, geometry and Achievement

Introduction

Science and technology have taken preeminent position in accelerating the growth and development of global economy. Obviously, growth and development of nations are functions of science and technology. It is therefore vital for scientific and technological skills to be transmitted from one generation to another through science education. In other words, science education is the platform that conveys scientific and technological information and knowledge to the recipients.

Mathematics plays invaluable role in science education. This presupposes that science subjects like Chemistry, Physics, and Biology cannot be effectively learnt without recourse to Mathematics. Joshua (2016) defined Mathematics as a discipline that trains the human mind to understand the world by symbolically and systematically performing reasoning and computation on abstract structures. Mathematics contributes greatly to fields of human endeavor without which no society would achieve greatness in terms of scientific and technological advancement. For This

reason, Herbert in Garba and Muhammad (2015) concludes that Mathematics is the queen and servant of all sciences. It could be argued that humans may necessarily survive considerably without learning how to read and write, but cannot sufficiently survive without learning how to count and calculate objects. This suggests that a good foundation in Mathematics is, therefore, vital for every aspect of human existence. In fact, a credit pass in SSCE Mathematics is a necessary condition for admission into higher institution in Nigeria. Hence, students are required to obtain at least a credit pass in Mathematics before they are admitted into higher institution in Nigeria.

The achievement of secondary school students in Mathematics in public examinations is, however, poor. The annual reports of West African Examination Council (WAEC) between 2010 and 2018, indicate a discouraging performance of students in the subject. The analysis of the achievement of students in May/June West African Senior School Certificate Examination (WASSCE) in Nigeria (WAEC, 2010-2018) for a period of nine years shows that the percentage of students who passed at credit level and above (A1– C6) was less than 40%; except in the years 2016 and 2017 when students' achievement increased to 52.97% and 59.22% respectively but regrettably decreased to 49.98% in 2018. Similarly, the analysis of the annual performance reports of WASSCE Nov/Dec. 2016, 2017, Jan/Feb. 2018 and Nov/Dec, 2018 shows that 17.6%, 23.6%, 18.3% and 35.99% of candidates respectively who registered for the examination obtained credit level and above (A1 –C6) while the rest scored below credit pass (Vanguard, November 21, 2018; WAEC, 2016, 2017, 2018). In reaction to this development, the Nigerian Senate directed its Committee on Education (Basic and Secondary) to find out the causes of the recurring high failure rate in Mathematics in the WASSCE with a view to suggesting some remedies (Vanguard, March 28, 2018).

In Imo State, the students' achievement in Mathematics at the WASSCE from 2015 to 2018 was poor and discouraging. The analysis of the achievement of students in May/June West African Senior School Certificate Examination (WASSCE) in Imo State shows that the percentage of students who passed at credit level and above (A1 –C6) was persistently less than 45% in the years 2015, 2016, 2017 and 2018. The Mathematics Chief Examiner's report for May/June and Nov/ Dec WASSSCE in Nigeria confirmed this poor trend in candidates' achievement in Mathematics; and explained that candidates have consistently shown significant weakness in geometry, particularly in chord properties, circle theorems and tangent to a circle and as a result, majority of the candidates avoid questions drawn from them (WAEC Chief Examiners' Report, 2011; 2013; 2014; 2015; 2016 & 2017). Fabiyi, (2017) corroborated this assertion. Fabiyi reported that chord property, circle theorem and tangent to a circle were among the concepts in geometry that students perceived difficult to learn.

Geometry provides knowledge of how to deal with measurements and relationships of lines, angles, surfaces and solids (Olojede, Bolaji & Musa, 2017). Furthermore, geometry enhances logical and deductive reasoning for modeling abstract problems and is widely applied in various areas of life, such as Computer Aided Design (CAD), modeling, robotics, medical imaging, computer animation and visual presentation (Jacob, Decl, Bolaji, Kajuru & Musa, 2017). Apparently, geometry is very useful to life.

The obvious usefulness of geometry notwithstanding, the achievement of secondary school students in geometry is poor. Specifically, Okigbo and Okeke (2011) stated that method of teaching

Mathematics is the major cause of poor achievement in Mathematics in general and geometry in particular. In the same vein, Usman et al. (2017) argued that the difficulty experienced by secondary school students in Mathematics is not unconnected with poor methodology of teaching Mathematics. Thus, in an attempt to remedy the ugly situation, researchers have suggested the use of various methods such as inquiry method, game and analogy, computer assisted instruction (Okigbo & Okeke, 2011). To this end, further intervention in terms of method of teaching is required in the effort to suggest better ways of remedying the poor achievement in geometry.

The method of teaching adopted by Mathematics teachers in Imo State is the conventional lecture method. Nworgu (2017) submitted that conventional lecture method is characterized by verbalization, memorization and non-interactive; with the teacher dominating instructional activities while the students remain basically inactive or passive in the classroom. This method, however, allows for a wider coverage of content within a short period of time and enables the teaching of large number of students at the same time (Osufor& Njoku (2016). More so, over 70 percent of science and Mathematics teachers in Nigeria is conversant with this method since it suits their pedagogic worldview. These merits notwithstanding, the demerits outweigh its merits as it does not promote activity learning, increase in interest and long – term retention of some concepts (Ahmed & Abimbola, 2011). What this means is that, it does not give students the room to use their initiative or participate actively in the lesson.

The contemporary pedagogic approach requires active participation of learners (Osuafor & Njoku, 2016), hence, paying much attention to the methods cum strategies used in teaching and learning geometry in secondary schools becomes necessarily imperative. There is, therefore, the need to explore teaching methods that may have the capacity to improve achievement of secondary school students in geometry. To this end, NERDC (2007) succinctly stated in senior secondary Mathematics curriculum that the computerized nature of the global world has led to the intensification of the use of computer in teaching many of the topics in Mathematics. As a result, many Computer Assisted Instruction (CAI) materials are recommended for the teaching and learning of various topics, especially the difficult ones. In support of the assertion, National Council of Teachers of Mathematics (NCTM, 2013) stated that the learning of Mathematics in the 21st century required technology; and that all schools must as a matter of importance endeavour to ensure that their students have access to technological innovations such as multimedia technologies. Hence, a lot of Computer Assisted Instruction (CAI) materials are recommended for the teaching and learning of various topics in Mathematics.

In consideration of the foregoing, in this 21st century, adoption of CAI with prospect of enhancing students' achievement has become increasingly needful. To this end, the use of CAI in teaching and learning of Mathematics implies that relevant instructional software packages that teach specific lessons particularly the difficult and abstract concepts such as geometry should be developed. Instructional software package is a combination of one or more files that necessitate the execution of a computer program for the purpose of communicating learning activities, skills and knowledge that are narrowed down to specific content areas to the learners in an interactive manner (Akukwe & Njoku, 2014). This means that the use of instructional software package is intended to make instructional activities learner-centred as against the conventional lecture method which is fundamentally teacher-centred. This implies that instructional software package so designed,

developed and applied should take into cognizance the characteristics, interests, educational needs of the learners and the philosophy of the subject needs. In view of the foregoing, the instructional software package advocated in this study is researcher-developed instructional software package called GeoTAN Instructional Software Package (GISP).

Etymologically, GeoTAN is derived from four words namely, Geometry, Text, Animation and Narration. GeoTAN Instructional Software Package (GISP) is an instructional software that can be used to teach geometric concepts specifically chord properties, circle theorems and tangent to a circle using text, animation and narration simultaneously to the learners in such a way that help learners build mental representations and construct knowledge by themselves. In other words, GISP is an instructional software package that runs on computer system which can be used to teach chord properties, circle theorems and tangent to a circle in an interactive manner which can help a learner to see the learning experience as text on the computer screen, hears it as it is described in words(narration) and sees the animation that shows illustration of how angles are formed and the position of angles in the diagram. GISP has the capacity to drill each student and at the same time and allows each student to work independently.

Furthermore, GISP is in line with the modern teaching approach which involves the use of various activities that make room for the active participation of learners to enhance meaningful understanding of the lesson (Nworgu, 2017). Therefore, GISP is a student-centred approach that allows the active participation of learners by presenting instructional activities in stages and in an interactive manner to students. In each lesson, the stages of presentation involve introduction, list of lessons, specific objectives of each lesson, test on previous knowledge, explanation of the learning activities both in text, narration(voicing) and animation; students' activities for evaluation and summary of the lesson. GISP has interactive features in that it shows the leaner whether the option selected is right or wrong. It also allows every student to navigate from one link to another using Home, Next, Back and Exit buttons.

Studies conducted on instructional software package have varying results. For instance, studies conducted in Mathematics on the effectiveness of instructional software by Akgül (2014), Michael, Omiola, Awoyemi & Mohammed (2014), Udobia (2018) show that instructional software improved the achievement of students more than the traditional teaching method in Mathematics. This, supports the studies of Kutluca (2013) and Ljajko and Ibro (2013) which reported that instructional software package improved the achievement of students more than the traditional teaching method in Mathematics. On the other hand, a related study carried out in United States of America, investigated the effect of instructional software package on students' achievement in Mathematics in high school grade 11 (equivalent to SS2 in Nigeria) (Martinez, 2017), reported that students who were taught geometry using traditional teaching method performed better than those exposed to instructional software package. In view of the contradicting findings by previous researchers, it becomes expedient to conduct more research on the use of instructional software package in teaching geometry in order to clear this inconsistency in findings and also determine the influence of gender on the achievement scores of students in geometry.

Gender is defined by Ezeh (2013) as the personality traits, attitudes, behaviours, values, relative power, influence, roles and expectation that society ascribes to the two sexes (male and female) on a differential basis. The influence of gender on achievement, interest and retention has

remained a controversial and an inconclusive issue amongst science educators and psychologists. For example, Kocaman and Kızılkaya (2014) reported that male students used instructional software more than female; and that male students performed better in foreign language in Turkey. The findings of Kocaman and Kızılkaya (2014) was contradicted by Maikudi, (2015) who reported superiority of females over males in achievement when taught geometry using instructional software package. From a neutral stance, Gambari, Shittu, Daramola, and Jimoh (2016) reported that there was no significant influence of gender on the mean achievement and interest scores of students taught Mathematics using instructional software package**.** This goes to show that the findings on influence of gender on achievement, interest and retention of students in geometry with respect to instructional software packages are inconclusive and this has created a need for further investigation in this study. The problems of this study, therefore, is: would the use of GISP for instruction enhance achievement of male and female secondary school students in geometry?

Purpose of the Study

The purpose of the study was to determine the effect of GISP on the achievement of secondary school students in geometry. Specifically, the purpose of the study was to:

1. determine the difference between the mean achievement scores of secondary school students taught geometry using GISP and those taught using Conventional Lecture Method (CLM).
2. determine the difference between the mean achievement scores of male and female students taught geometry.
3. determine the interaction effect of teaching method and gender on mean achievement scores of students in geometry.

Research Questions

The following research question guided the conduct of the study.

1. What are the mean achievement scores of students who were taught geometry using GISP and those taught using CLM?
2. What are the mean achievement scores of male and female students who were taught geometry using GISP and those taught using CLM?

Hypotheses

The following hypothesis was tested at 0.05 levels of significance.

1. There is no significant difference between the mean achievement scores of students who were taught geometry using GISP and those taught using CLM.
2. There is no significant difference in the mean achievement scores of male and female students who were taught geometry.
3. There is no significant interaction effect of teaching method and gender on mean achievement scores of students who were taught geometry.

Methodology

Two research designs were adopted in this study; namely, instrumentation and quasi-experiment. The sample of the study consisted of 240 SS2 students in public secondary schools in Imo State and was selected through a multistage sampling from two boys and girls; and two co-educational secondary schools. That is, purposive sampling technique was used in selecting two boys and girls; and two co-educational secondary schools from the six LGAs based on some predetermined criteria, namely; school type (public school, single sex and co-educational), availability of ICT equipment (computer laboratories) and existence of SS2 class. This process culminated in the selection of six public secondary schools. The selected public secondary schools were assigned to each of the experimental and control groups using simple random sampling technique. The treatment in experimental group was teaching with GISP.

GISP was developed by the researcher based on the content of SS2 Mathematics scheme of work. It covered the following topics in geometry; chord property, circle theorem and tangent to a circle. The reason for researcher-made package is that the available commercially produced packages are not directly relevant to the topic or objectives to be achieved in this study. As a result, GISP was developed using the following application software namely; Cinema 4D, Macromedia Flash 8, Macromedia Fireworks 8, Microsoft Word and Adobe Audition. Cinema 4D was used to create the 3-dimentional images. Macromedia Fireworks 8 was used to create 2-dimentional images. This is because it allows very tiny file size compared to other graphic application software. Macromedia Flash 8 enabled the assemblage and embedment of graphics, text, interactive features and audio in the software. In fact, Macromedia Flash 8 was used as the overall platform. Microsoft Word was used for formatting the text. Lastly, the adobe audition was used for recording voice**.** The GISP development was perfected through the assistance of professional computer programmer. In validation of GISP, two types of validation were used – the face and content validations. The face validation was done by educational technologists and computer programmers while the content validation was done by Mathematics specialists. On the other hand, field validation was done by the SS2 students.

The instrument used for collection of data in this study was Geometry Achievement Test (GAT). GAT was developed by the researcher based on the topics chosen for the study. GAT consists of two parts, I and II. Part I is the preliminary part which made provisions for getting bio-data of the student. Part II contains 40-item multiple-choice questions with four response alternatives A-D. GAT was developed based on the following topics: chord properties of circle, circle theorem and tangent to a circle from SS2 scheme of work in Mathematics. GAT was administered on the students before the treatment starts as pre-test. Immediately after the treatment, GAT was re-arranged starting with item from the bottom and administered to the same students in their classrooms as post-test. On the scoring of GAT, two and a half marks was awarded for each correct answer and zero for each wrong answer. Any students' score that contained 0.5 was rounded up to the nearest whole number. GAT was subjected to item analysis. For the purpose of item selection, all items with difficulty indices ranging between 0.71 to 1.0 were classified as too cheap while those with indices between 0.10 to 0.29, were classified as too difficult. Therefore, the range of difficulty indices selected was 0.30 to 0.70. This agreed with the submission of Anene and Ndubuisi (2015). Similarly, all items with

discrimination indices between the range of 0.30 to 1.00 were selected but the researcher did not select those whose discrimination indices were less than 0.30. For the distractor indices, all options with zero or negative values were rejected in this study. However, the options with distractor indices greater than zero were selected. Finally, the difficulty indices of the items were used in arranging GAT items according to their increasing order of difficulty.

Thereafter, GAT was subjected to face and content validity. In order to establish the reliability of the instrument, both the internal consistency and temporal stability of the instrument were computed. The test items in GAT were validated by experts in mathematics education and; measurement and evaluation. GAT was tested for reliability using 30 randomly selected SS3 students outside the study area. A reliability test using the Kudar-Richardson (KR-20) revealed a reliability coefficient of 0.91 for internal consistency which was considered adequate for the research study. Since the instrument would be used twice, the temporal stability of GAT was established using test-retest. To this end, GAT was administered the first time to 30 students and later it was administered again to the same students after two weeks. The Pearson Product Moment Correlation was used to obtain correlation co-efficient of 0.92 which was considered adequate for the research study.

Experimental Procedure

The researchers coordinated the regular Mathematics teachers of the selected schools for the experimental group on how to use the GISP for teaching geometry for one week. Thereafter, a copy of GISP in compact disk and instructional guide were given to all the teachers in experimental group. However, all the teachers in the control group were giving only the validated copy of Lesson Plan Geometry. In the schools sampled for the study, three intact classes were randomly assigned to the experimental group and another three intact classes to the control group. Before the commencement of the treatment, the instruments, GAT and GII were administered to the students as pre-test by the researcher with the help of research assistants (regular Mathematics teachers), and their score were recorded. No feedback on the pre-test was given to the students.

The treatment in the experimental group in this study was teaching using the GISP and this lasted for five weeks. In the three sampled schools assigned to the experimental group, the research assistants (regular Mathematics teachers) ensured that the computers were in good working condition. Thereafter, projectors were properly set and computers booted. During the first 40-minute lesson, students from the experimental group were given a short introduction on how to use GISP. That is familiarizing the students with GISP.

Control of Extraneous Variables

The following measures were taken by the researchers to control extraneous variables likely to adversely affect the conduct of the experiments and the results that would be obtained thereof:

Teacher Factor: The materials for teaching the students were prepared by the researchers. The same regular Mathematics teachers taught the students in both groups.

Hawthorne Effect: To ensure that the students were not aware that they were being used for experiment, the regular Mathematics teachers were used as the research assistants and the contact teaching period of the study was within the schools' normal time-table.

Possible Intermingling of Participants: The experimental and the control groups were located in schools in different LGAs far from the other to avoid possible mass contact between student groups undergoing different treatments and contamination of the results of the study.
Initial Group Difference: Due to the nature of the administrative set up in the schools, there was non-randomization of the research subjects because the students were already organized in classes. As a result, intact classes were used in this study**.** It implies that the treatment and control groups were not equivalent at the onset of the experiment. ANCOVA was used for data analysis in order to eliminate the differences in groups used in this study.
Effect of Pre-test on Post-test (Test Knowledge): The items in the instrument were re-arranged before administering the post-test in the fifth week.
Researcher Bias: The experimental and control groups were randomly assigned to groups by the researcher. The lesson plans for the instruction were strictly followed. The regular Mathematics teachers administered the test while the researchers graded the scripts and recorded the scores.

Method of Data Analysis

On the analysis of data, all the data were cleaned to ensure that outliers were not present in the data (Dimitrov, 2012). Thereafter, the researcher computed the mean, standard deviation of achievement scores. The mean and standard deviation were used to answer research questions. Whereas Two-way Analysis of Covariance (ANCOVA) was used to test the other hypotheses at 0.05 level of significance. The reason for using ANCOVA was that it is a statistical tool that removes confounding variables (initial group difference) such as differences in intelligence between the experimental and control groups from the possible explanations of variances in the dependent variable (post-test). In taking decision, if the p-value was less than or equal to the significant value of 0.05($P \leq 0.05$), the null hypotheses were rejected; otherwise ($P > 0.05$) they were not rejected.

Results

Research Question 1: What are the mean achievement scores of students who were taught geometry using GISP and those taught using CLM?

Table 1
Mean and standard deviation of achievement scores of students taught geometry using GISP and those taught using CLM.

Source of Variation	N	Pre-test $\bar{X}$	Post-test $\bar{X}$	Mean ($\bar{X}$) Gain	SD Pretest	SD Posttest
GISP	116	21.21	61.47	40.26	6.43	8.50
CLM	124	20.60	43.64	23.26	6.12	8.21

The result presented in Table 1 reveals that the students exposed to GISP had a pre-test mean achievement score of 21.21 with a standard deviation of 6.43 and a post-test mean achievement score

of 61.47 with a standard deviation of 8.50. The mean gain achievement score of the students exposed to GISP is 40.26. The students exposed to CLM had a pre-test mean achievement score of 20.60 with a standard deviation of 6.12 and a post-test mean achievement score of 43.64 with a standard deviation of 8.21. The mean gain achievement score of the students exposed to CLM was 23.04.

Research Question 2: What are the mean achievement scores of male and female students who were taught geometry using GISP and those taught using CLM?

Table 2
Mean and standard deviation for achievement scores of male and female students taught geometry using GISP and those taught using CLM.

Source of Variation	Gender	N	Type of Test	Statistics $\overline{X}$	SD
GISP	Male	54	Post test	61.28	8.76
			Pre test	20.00	6.19
			Mean Gain	41.28	
CLM	Male	57	Post test	43.36	9.24
			Pre test	19.82	5.30
			Mean Gain	23.54	
	Total	111			
GISP	Female	62	Post test	61.63	8.33
			Pre test	22.23	6.55
			Mean Gain	39.40	
CLM	Female	67	Post test	43.88	8.21
			Pre test	20.04	5.73
			Mean Gain	23.84	
	Total	129			

The result presented in Table 2 reveals that the male students exposed to GISP had a pretest mean achievement score of 20.00 with a standard deviation of 6.19 and a posttest mean achievement score of 61.28 with a standard deviation of 8.76. The mean gain achievement score of male students exposed to GISP was 41.28. The female students exposed to GISP had a pretest mean achievement score of 22.23 with a standard deviation of 6.55 and a posttest mean achievement score of 61.63 with a standard deviation of 8.33. The mean gain achievement score of female students exposed to GISP was 39.40.

Table 2 reveals also that male students exposed to CLM had a pretest mean achievement score of 19.82 with a standard deviation of 5.30 and a posttest mean achievement score of 43.36 with a standard deviation of 9.24. The mean gain achievement score of male students exposed to CLM was 23.54. The female students exposed to CLM had a pretest mean achievement score of 20.04 with a standard deviation of 5.73 and a posttest mean achievement score of 43.88 with a standard deviation of 8.21. The mean gain achievement score of female students exposed to CLM

was 23.84.

Testing Null Hypotheses

Hypothesis 1: There is no significant difference between the mean achievement scores of students who were taught geometry using GISP and those taught using CLM.

Table 3
Summary of Two-way Analysis of Covariance (ANCOVA) of achievement scores of students taught geometry using GISP and those taught using CLM.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	28198.631[a]	4	7049.658	222.824	.000	.791
Intercept	18653.510	1	18653.510	589.597	.000	.715
Pretest	9136.463	1	9136.463	288.784	.000	.551
Method	16491.831	1	16491.831	521.271	.000	.689
Gender	50.100	1	50.100	1.584	.209	.007
Method * Gender	64.392	1	64.392	2.035	.155	.009
Error	7434.865	235	31.638			
Total	690953.000	240				
Corrected Total	35633.496	239				

a. R Squared = .791 (Adjusted R Squared = .788)

The result in Table 3 shows that there is a significant effect of GISP on students' achievement in geometry; F(1, 235) = 521.271, P < 0.0005, with an effect size of 0.69 ***(partial eta squared = 0.689)***. The null hypothesis was therefore rejected. Thus, there is significant difference between the mean achievement scores of students who were taught geometry using GISP and those taught using CLM. In other words, that there is a significant difference between the mean achievement scores of students who were taught geometry using GISP and those taught using CLM. The result suggests that students who were taught geometry using GISP achieved higher than those taught using CLM.

Hypothesis 2: There is no significant difference in the mean achievement scores of male and female students who were taught geometry.
Hypothesis 2 was tested with ANCOVA in order to determine the influence of gender on students' achievement scores in geometry and the result of the test is summarized in Table 3. Table 3 reveals that there is no significant effect of gender on students' achievement scores in geometry. That is, F(1, 235) = 1.584, P = 0.209. The null hypothesis was not rejected and the result indicates that there is no significant difference in the mean achievement scores of male and female students in geometry.

Hypothesis 3: There is no significant interaction effect of teaching method and gender on mean achievement scores of students who were taught geometry.

Hypothesis 3 was tested with ANCOVA and the result of the test is summarized in Table 3. Result in Table 3 shows that there is no significant interaction effect of method and gender on students' mean achievement scores in geometry; F(1, 235) = 2.035, P = 0.155. The null hypothesis was not rejected. The result, therefore, suggests that interaction effect of method and gender on students mean achievement scores in geometry does not influence students' achievement in geometry.

Discussion

The result revealed that the mean achievement score of students taught geometry using GISP was higher than those taught with CLM as shown in Table 1. This means that students taught geometry using GISP improved more in achievement score than the students taught with CLM. This observed difference was subjected to inferential testing (ANCOVA) in order to find out whether the difference was as a result of error variance. Results in Table 3 further confirms that there is significant difference between the mean achievement scores of students who were taught geometry using GISP and those taught using CLM. Therefore, the students' achievement in geometry in this study improved when taught using GISP than when taught using CLM. This finding affirms that the use of GISP in teaching and learning geometry in secondary school is more efficacious than the CLM.

This finding is in agreement with some previous research findings by Akgül (2014), Michael et al (2014), Onah (2015), Ominowa, and Bamidele (2016**);** Usman et al, (2017) and Udobia (2018) who respectively reported that students taught using instructional software packages achieved more than students taught using CLM. However, this finding is not in agreement with the finding of Martinez (2017) who reported that students who were taught geometry using traditional teaching method performed better than those exposed to instructional software package.

The inconsistency in previous research findings notwithstanding, the finding of the present study has made it clear that GISP is more effective than CLM in enhancing students' achievement in geometry. The reason for this could be attributed to the fact that the computer was a teaching and learning tool that minimised the dominance of the teacher in the learning setting while increasing individual students' participation in lesson. Students were more actively involved in building their own understanding of geometry. Hence, the students were able to visualize the objects. The principle of readiness, step by step presentation of learning experiences, and receiving of immediate feedback that were imbedded in GISP may have been responsible for increase in achievement. Also, the independent study ability of the students taught geometry using GISP was enhanced tremendously.

The analysis of data specifically male and female achievement scores presented in Table 2 shows that the male students who were exposed to GISP had higher mean achievement score than female students who were exposed to GISP. However, female students who were exposed to CLM had higher mean achievement score than male students who were exposed to CLM in Table 2. Afterwards, in order to ascertain whether this observed difference is attributable to error variance, this result was subjected to inferential testing (ANCOVA) as presented in Table 3. Result in Table 3 the test of hypothesis 2, showed that there was no significant difference between male and female achievement scores of students who were taught geometry. That is, gender had no significant influence on students' achievement scores in geometry. What this means is that gender does not influence the mean achievement scores of students who were taught geometry. This finding is in

agreement with the findings of Kudu (2013), Gambari et al, (2014) and Onah (2015) who reported in their respective studies that students taught using instructional software package method achieved higher mean achievement scores than those taught using CLM in Physics and Mathematics respectively and that gender does not influence the mean achievement scores of students. This finding, however, disagrees with the finding of Koni et al, (2019) who reported that male students performed better than female students taught mathematics with CAI package and that boys have stronger affinity to CAI package in mathematics than females.

The result of hypothesis 3 shows that there is no significant interaction effect of method and gender on mean achievement scores of students in geometry. This finding agrees with the findings of Giginna (2013**),** Okorie (2015) and Onah (2015) who reported in their separate studies that the interaction effect of teaching methods and gender on students' achievement scores in chemical bonding and Mathematics was not significant.

Conclusion

Based on the findings presented and discussed in this study, the following conclusions have been made. There is concordance among Mathematics educators that the subject matter contents of the developed GISP sufficiently covered the required areas of geometry based on senior secondary school (SS2) Mathematics curriculum. GISP has significant effect on students' achievement, interest and retention in geometry. GISP was more effective in improving students' achievement, interest and retention in geometry. The influence of gender on achievement, interest and retention scores of students in geometry was not significant. The interaction effect of method and gender on mean achievement scores of students in geometry was not significant. The interaction effect of method and gender on mean interest scores of students in geometry was not significant.

Recommendations

From the findings of this study, the following recommendations are made:

1. Mathematics teachers should use GISP in teaching geometry in senior secondary school.
2. Mathematics and science teachers should be trained by teacher training institutions on how to develop instructional software package for teaching and learning in secondary schools.
3. Computers should be provided by government agencies, charity organizations and other stakeholders in the school system for effective utilization in teaching/learning of geometry at the secondary schools.

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References

Ahmed, M. A. & Abimbola, I. O. (2011). Influence of teaching experience and school location on biology teachers' rating of the difficult levels of nutrition concepts in Ilorin, Nigeria. *JOSTMED*, *7*(2), 52 -61.

Akgül, M. B (2014). *The effect of using dynamic geometry software on eight grade students' achievement in transformation geometry, geometric thinking and attitudes toward mathematics and technology*. (Unpublished master's thesis), Middle East Technical University, ***Ankara*** Turkey.

Akukwe A. C.& Njoku, J.I (2014). Introduction to computer studies. Owerri: Onii Publishing House.

Dimitrov, D. M. (2012). *Statistical methods for validation of assessment scale data in counseling and related fields*. Alexandria, VA: American Counseling Association.

Ezeh, D. N. (2013). Science without women: A paradox. *An Inaugural Lecture of the University of Nigeria Nsukka.*

Fabiyi, T.R. (2017). Geometry concepts in Mathematics perceived difficult to learn by senior secondary school students in Ekiti State. *IOSR Journal of Research & Method in Education (IOSR-JRME)*, 7 (1), 83-90.

Gambari, A. I, Shittu, A. T, Daramola, F. O. & Jimoh, M. A. (2016). Effects of video instructional packages on achievement of senior secondary school students in mathematics. *ATBU, Journal of Science, Technology & Education (JOSTE)*, 4 (2), 179-196.

Giginna, L.I***(2013). Effect of animation instructional strategy on students' achievement, interest and retention in chemical bonding.*** (Unpublished doctoral dissertation) University of Nigeria Nsukka.

Jacob, T. A, Decl, C. Bolaji, Y. K., Kajuru, M. M. & Musa, K. B. (2017). Effect of concrete manipulative approach on attitude, retention and performance in geometry among junior secondary school students in Benue State. *IOSR Journal of Research & Method in Education*,7(6), 80-175.

Joshua, M.T(2016). *Communication technologies and Science, Technology, Engineering and Mathematics (STEM) education*. Keynote address presented at the 57th annual national conference of Science Teachers Association of Nigeria from 15th-20th August, 2016 at government college, Ado Ekiti.

Kocaman, O & Kızılkaya, C. G (2014). The effect of educational software (DENIS) and games on vocabulary learning strategies and achievement. *Education and Science, 39*(176), 305-316.

Koni, G. O, Zephaniah, F. F & Mercy, O. (2019). Effect of Computer Assisted Instructional Package on secondary school students' achievement in arithmetic progression in Port Harcourt Local Government Area, Rivers State. *International Journal of Education and Evaluation*. 5(3), 33-42.

Kudu, M. S. (2013). Effect of computer assisted cooperative learning strategy on students retention in physics among secondary schools in Minna Metropolis, Niger State. *IOSR Journal of Research & Method in Education (IOSR-JRME),* 9(5)51-58**.**

Kutluca, T. (2013). The effect of geometry instruction with dynamic geometry software; GeoGebra on Van Hiele geometry understanding levels of students. *Educational Research and Reviews*,

8, 1509-1518.

Ljajko, E., & Ibro, V. (2013). Development of ideas on a GeoGebra-aided mathematics instruction. *Online Submission, 3*(3), 1-7.

Martinez, A. R (2017). *The effects of using Geogebra on student achievement in secondary Mathematics* (Unpublished Master's Thesis), California State University.

Michael, A.F., Omiola, M.A., Awoyemi, S.O. & Mohammed, R.E. (2014). Effect of computer assisted instructional package on the performance of students in Mathematics in Ilorin metropolis. *European Scientific Journal*,10(25), 196-199**.**

Nigerian Educational Research and Development Council (NERDC, 2007). *New senior secondary education structure at a glance*. Lagos: NERDC Press.

National Council of Teachers of Mathematics. (2013). *Principles and standards for school mathematics*. Reston, VA: NCTM.

Ntshengedzeni, R. M (2015). *Enhancement of learners' performance in geometry at secondary schools in Vhembe District of Limpopo Province*. (Unpublished doctoral dissertation) University of Venda. Venda,

Nworgu, B. G. (2017). *Modern teaching approach*. Paper presented at the one-day stakeholders' forum on e-curriculum. Nigerian Educational Research & Development Council (NERDC). Retrieved from http:www.facebook.com/NERDC/.

Okigbo, E.C., & Okeke, E.U. (2011). A comparison of the use of card games and expository method in teaching and learning algebraic expressions. *UNIZIK Journal of STM Education, 1*(1), 18 – 24.

Okorie, E. U. (2015). Effects of instructional software package method of teaching on students' interest and achievement in chemical bonding. *Education*. 5(6): 158-165. DOI: 10.5923/j.edu.20150506.02

*Ominowa, O. T. & Bamidele, E. F. (**2016).** Effectiveness of video-mediated instruction on teaching secondary school practical chemistry in Akure South Local Government Area of Ondo State, Nigeria.* ***European Journal of Education Studies 2****(**5**), 79-89.*

Onah, E. N. (2015). *Effect of multimedia projection on senior secondary students' achievement and interest in sets in Enugu State, Nigeria*. (Unpublished doctoral dissertation), University of Nigeria Nsukka.

Osuafor, A. M. & Njoku, C. (2016). Effect of prior knowledge of behavioural objectives on mathematics achievement of high and low mental ability secondary school students in Imo State, Nigeria. ***People:*** *International Journal of Social Sciences,*2 (1) *255-264.*

Usman, B. A., Wishishi, D. I., Gambari, A. I. & Olayinka, O. (2017). Effect of developed web-based instructional package in Hausa language on academic achievement of upper basic students in geometry in Niger State. *ATBU, Journal of Science, Technology & Education (JOTE)*, 5(2), 109-118.

Vanguard, Newspapers (November 21, 2018). *Waec-releases-2018- wassce-results for private candidates recording 60% failure/*. Retrieve from https://www.vanguardngr.com.

West African Examination Council (WAEC) (2010 – 2018). *Chief Examiners' Reports.* Yaba: Lagos State.