Effects of Information Communication Technology on Senior Secondary School Students' Geometry Retention and Performance in Bauchi State Nigeria.

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Abstract. *This study investigated the "Effects of Information Communication Technology on Senior Secondary School Students' Geometry Performance and Retention in Bauchi State Nigeria". The study, which adopted a quasi-experimental design and a non-equivalent, pretest, posttest, post posttest in nature have two intact classes assigned, one to control and the other to experimental group in two coeducational schools as a fair representation of 25 schools comprising of 8200 students within the metropolis of Bauchi state. The sample groups consisted of 128 (SSII) students with 54 boys and 74 girls. The data generated using the instrument, Geometry Performance Test (GPT) which comprised of 76 items validated by three experts (professors in the Faculty of Education) and subsequently pilot tested with reliability coefficient of 0.86 drawn from WAEC, NECO, JAMB and other relevant past questions. The research questions and hypotheses were formulated to be answered and tested respectively using descriptive statistics and independent t-test with two-way ANOVA to test the hypotheses at 0.05 level of significance. The findings of the research revealed among others that the students who were taught using ICT method of teaching showed significant improvement in their performance in geometry than the students who received instruction through the traditional lecture method. The research also revealed that the ICT use in the teaching contributed towards raising their retention ability in geometry. Hence, the study recommended the use of ICT teaching strategy in all levels of secondary school mathematics and that mathematics teachers needed to be trained and developed on this strategy to enhance teaching capability.*

Keywords: Geometry, Mensuration, Information Communication Technology, Academic performance, Retention.

I. INTRODUCTION

There is no nation that develops beyond its scientific and technological attainment and the back bone of this development is Mathematics. As it is in our planetary model, the Sun is a star and the remaining planets revolve around the sun. Similarly, Mathematics is a star in the centre and all the other subjects revolve around the Mathematics. It plays central role in all facets of modern human endeavour ([1], [2]). Neglect of mathematics works injury to all knowledge. Its teaching and learning is crucial to the future of Nigeria knowledge economy and deserves a special focus in education [2]. Despite all the noble efforts, the problem of poor performance in mathematics particularly in geometry is associated with a cluster of variables among which statistics had shown that it is directly related to poor instructional method of teaching and learning. This is in consonance with [3] and [4], who attributed incessant failure and poor performance in mathematics to ineffectual teaching method. The mass failure in mathematics examinations is real and the trend of students' performance has been on the decline [5]. This research investigated the core topics in geometry where students experience poor performance and re-strategizes ICT method in teaching them. Topics such as plane and solid shapes, measurement of plane and solid shapes, including surface areas and volumes of solids, polygons, geometrical ratio, geometrical transformation, latitude and longitude and so forth are topics that are generally identified to be difficult by both students and teachers. This study focused on surface areas and volumes of cube, cuboids, cylinder, cone, sphere and hemisphere. Many scientific and technological fields require the knowledge of geometry. Especially in the more advanced and specialized fields of study the use and knowledge of geometry is essential to excellence.

In this study, a teacher who uses technology effectively is defined as one who is able to combine their content knowledge, pedagogical knowledge, and technological knowledge which is known as Technology Pedagogical Content Knowledge (TPACK) to facilitate classroom activities, using technology as a tool to support learning where

students are able to understand, analyze, and synthesize information by constructing representations of their own knowledge [6]. The role of ICT in this work is to investigate how it affects the academic performance and retention of senior secondary school students in geometry. Academic performance is the educational goal that is achieved by a student, teacher or what institution achieves over a certain period.

Objectives of the Study.

The primary objective of this study was to investigate the effects of the ICT power point animated method on the senior secondary school students' geometry performance and in more specific terms the study equally has the following objectives to;

i. determine the effect of ICT on students' academic performance in geometry particularly in solid shapes

ii. investigate the effect of ICT on retention ability of senior secondary schools students' in geometry

Research Questions

The following research questions were formulated and answered:

i. What is the effect of ICT on the students' performance in geometry compared to the performance of those exposed to conventional method?
ii. Will there be difference in the retention level of SSII students that were taught with the ICT PowerPoint animation method and their counterparts that were taught with conventional method, in geometry?

Null Hypotheses

The following hypotheses were tested at $\alpha \leq$ 0.05 level of significant.

i. **H_{01}**. There is no significant difference in the mean of students' academic performance scores in geometry taught using ICT and those taught using lecture method.
ii. **H_{02}**. There is no significant difference in the retention ability of students taught with ICT PowerPoint animation method and those taught geometry with conventional method.

II. LITERATURE REVIEW

This study adopted the constructivist theory of learning. The constructivist theory was chosen because it builds on prior knowledge: students use what they already know to make connections to new material. When students make these connections, they are learning new material and relating it to what they already know. Reference [7] discussed how ICT is based on the constructivist theory of learning, because knowledge is actively constructed by the students while they are making constructions and analyzing figures instead of knowledge being passively received and accepted.

The research work explored to find the effect that ICT method of teaching has over the lecture method. Several literatures were reviewed in the course of this study ranging from the theoretical framework, teaching of geometry at senior secondary schools, ICT and mathematics teaching, retention and performance in geometry, among others, as well as overview of similar studies to the implications of all these literatures on the present study.

The views of some of the researchers considered in the literature review of this work, many of which argued against the supper effect of ICT method while others are in support. [8], examining the integration of standards-based *video clips* into lessons developed by classroom teachers found increase in student achievement in a study of more than 1,400 elementary and middle school students in three Virginia school districts, showing an average increase in learning by students exposed to the video clip application compared to students who received traditional instruction alone.

[9], in a study of eighth graders using a *hypertext/ multimedia* tool to design their own lessons about the American civil war, revealed that the scores of students using the *multimedia tool* did not differ from the scores of the control group on a test given at the completion of the lesson. However, when tested one year later by an independent interviewer, the *multimedia group* displayed elaborate concepts and ideas that they had extended to other areas of history. In contrast, the control group of students remembered almost nothing about the historical content of the civil war lesson. The results revealed that multimedia tends to have long term effects on understanding and retention.

[10], comparing the effectiveness of *hypermedia* to traditional lecture for graduate students studying safety and industrial hygiene, in retention to the topic of instruction noise and hearing conservation, found that the students who used the hypermedia program demonstrated significantly superior achievement on a test of hearing conservation concepts and principles. [11] too found that *hypermedia* tools offer new methods for structured discovery, address varied learning styles, motivate and empower students and allow educators to present information as a web of interconnections rather than a stream of facts.

[12], comparing the geometry performance of two groups of pre-service elementary teachers enrolled in a mathematics methods course, both groups completed hands- on, experiential activities designed to help them develop a deeper understanding of the concept of similar geometric figures. The control group used manipulative and traditional tools such as a protractor and ruler, together with a mechanical device for drawing similar figures. The experimental group used *Geometer's sketchpad* software, showed that students using the Software performed significantly better on a posttest measuring understanding of the concept of similarity and that the use of the *GSP* in teaching and learning mathematics is a useful and attractive program that can create a healthy atmosphere in the educational process.

[13], presenting nine exercises on using different technological tools – GSP one of them – in explaining *Calculus* Concepts, found that the GSP can be used in teaching some of Calculus Concepts such as: vertices of a triangle, midpoint, equation of a line, slope of a line, and the trigonometric identities of sine, cosine, and tangent functions. [14], investigating the effect of using the *GSP* on high school students' attitudes towards geometry, indicated that the scores of the pre-test and post-test of the students in the experimental group were significantly different and that *there were significant differences* also between the control and experimental groups' gain scores from the pre-test to the post-test.

[15], exposed ninth graders enrolled in algebra classes with traditional instruction to one of three conditions: 1. a control group; 2. a Placebo condition, where students were given a computerized word problem environment without active tutoring; and 3. an experimental group that received a computerized word problem environment with native tutoring, found that students who received *computerized tutoring system performed* better both on abstract and concrete reasoning word problem tasks than their age- mates in the other two conditions. However, they did not do better than students given human tutoring as a supplement to traditional instruction. In addition, although the *tutoring system* was designed to increase the ability to solve problems of a more abstract and theoretical nature, the students actually showed more improvement on concrete test questions than on abstract ones. Because the students were not assigned to conditions randomly, may be the results are attributable to the pre-existing differences between the control and experimental groups; as the experimental group scored significantly higher on test problems even before the manipulation. Notwithstanding its limitations, the study provides limited support for the argument that the use of computer tutorial programs has the potential to help students with problem solving skills, which is a concrete position that this research justifies. Retention of knowledge is an important area of research that has the potential to inform instructional practices and school learning goals. It is the ability to retain and later recall information or knowledge gained after learning ([16], [17], [18]). According to [19], who identified over 200 published texts dealing with the use of ICT in science education from 1994 to 2002, from their search they concluded that teacher educators are unfamiliar with the literature that has been published because it is situated in journals that are not familiar to most science educators. If science teacher educators are unaware of the findings of research into ICT in science education and hence of the affordances of various types of ICT for learning science, there is little hope that many science teachers will be adequately knowledgeable about the value of ICT in their teaching.

[20] reported that developmental mathematics students at a community college learned significantly more from an-hour *animated software* tutorial on *matrix Algebra* than from a *static one*. Animation was used mostly to highlight symbols, objects, and "Morphing of addition elements and multiplication factors into sums and products." Students could stop or repeat animation or alter the variables from a menu. A third (control) group read for an hour from a commercial algebra text. Smith found that both the static-CAI and the animated-CAI students performed *significantly better* than the text group on the immediate post-test. Animation seems to have had a *positive impact* on content retention for students in this study.

[21] comparing the effects of three instructional approaches for teaching college-level lessons in human resource development; that is, conventional lecture-demonstration*;* interactive video with students handling the computer controls; and interactive video with the instructor handling the computer controls found no significant achievement differences between students who directly controlled the computer and those who did not, though both videodisc approaches resulted in significantly higher levels of student achievement than conventional instruction in a test of initial learning and a delayed test to measure retention

The present study has generated some interesting findings concerning the benefit of using ICT in teaching a Mathematics topic as compared to the traditional method of teaching. Results indicated that ICT used method of teaching significantly improved students' performance on the performance test and their retention level in answering the questions after this intervention. However, there were significant differences in students' performance and retention level when the students who were taught using ICT

were compared to those taught using traditional methods. ICT-used method of teaching seemed to be very effective in enhancing students' conceptual understanding as well as improving their retention level which is a sign of the effectiveness and uniqueness of the special features in PowerPoint animated presentation programme. It can, therefore, be inferred and summarized that ICT-used teaching strategy is effective for the teaching of Mathematics.

III. METHODOLOGY

This study was quasi-experimental in nature. It was non- equivalent pretest, posttest, post-posttest control group in design. This design was adopted because it is not possible to undertake true experiment in social sciences. There was no randomization of subject since this might disrupts school organization, hence, intact classes of SS II students were randomly assigned to experimental and control groups respectively as a fair representation of 24 schools comprising of 8200 students within the metropolis of Bauchi state. The sample groups consisted of 128 (SSII) students with 54 boys and 74 girls.. The experimental group was taught through ICT used teaching method and the control group through lecture method. The intact groups were tested for homogeneity in terms of academic performance, gender and retention. The research design is illustrated in Figure 3.1.

$E_G \rightarrow O_1 \rightarrow X_1 \rightarrow O_2 \rightarrow O_3$

$C_G \rightarrow O_1 \rightarrow X_0 \rightarrow O_2 \rightarrow O_3$

Figure 3.1 Research Design Illustration

E_G = Experimental Group; C_G = Control Group; X_1 = Treatment (ICT); X_0 = Lecture Method; O_1 = Pretest; O_2 = Posttest; O_3 = Post post test.

Population of the Study

The targeted population of this study comprised of all state owned Senior Secondary Schools in the metropolis of Bauchi State. The total population of eight thousand two hundred (8,200) SS II students comprising four thousand six hundred and forty five (4,645) males and three thousand five hundred and fifty five (3,555) females. Nineteen (19) out of these twenty four (24) schools were coeducational with six thousand one hundred and eighty nine (6,189) students and only three schools did not separate their classes gender wise which made a total of one thousand seven hundred and forty three (1743) students. The schools with ICT capacity were thirteen (13) with the total of six hundred and eight (608) computers.

Sample and Sampling Procedures

Stratified sampling was adopted in this study which is a commonly used probability method that is superior to random sampling because it reduces sampling error. The researcher first identified the relevant stratums and their actual representation in the population. Random sampling was then used to select a *sufficient* intact class from each stratum. *Sufficient* refers to a sample size large enough for us to be reasonably confident that the stratum represents the population.

In this study, 19 out of 24 schools were coeducational out of which only 3 did not separate their classes gender wise (Those 3 comprise of 1743 students) and 2 of them were randomly selected so as to equally investigate the gender effect of the ICT. Each of the selected schools had four intact SS II classes and a sample of two intact classes of senior secondary school II students was drawn randomly by ballot, one from each coeducational schools within Bauchi metropolis notwithstanding the availability of computer laboratories since the researcher prepared for the required equipment. The details of the two selected schools used as the experimental and control groups is presented in Table 3.2.

Table 3.2: Sample for the Study

S/N	Groups	Boys	Girls	Total
1	**GDSS Gwallameji** (Control)	32	22	54
2	**GDSS Army Barrack** (Experimental)	46	28	74
Total		**78**	**50**	**128**

Instrumentation.

The instruments used for the study are, the Intelligent or Ability Status Test on geometry known as Pre test, the Geometry Performance Test referred to as Post test and Retention Test known as Post post test. The stages involved pre-testing of all the students of both groups (after an earlier familiarization tour with the students) on their ability level or intelligence and academic performance in geometry. This was done to determine the status or the ability level of the students on their understanding of the concept of geometry through the use of Geometry Performance Test (GPT). The post test stage involved the experimental treatment, which consisted of five subunits of senior secondary geometric mathematics, that is; cuboids, cylinder, cone, sphere and hemisphere taught through ICT-based teaching and through traditional teaching to control group for six (6) weeks. On the conduct of the experiment, the instructional treatment was given to the experimental group, whereas the control group

was taught by the lecture method. The same content was taught to both groups and the researcher taught both the control and the experimental groups on areas, volumes and other parameters of the selected solid shapes popularly known as mensuration. Immediately after the instructional treatment was over, the researcher tested the subjects of experimental group and control group on the dependent variable (academic performance in geometry). Time allowed for the GPT was one hour thirty minutes which was an extension of time spent during pilot testing with additional ten minutes. The answer sheets, scored with the help of scoring key. The scores indicated the previous knowledge possessed by the students and their performance in geometry. Retention Test, this stage dealt with post-post testing of the control and experimental group after two weeks of the post testing using the Geometry Performance Test; reshuffled to determine the effect of the treatment on the students' retention ability in geometry.

Validation of the Instrument

The Researcher prepared a thorough study on, lateral and surface areas and as well volumes of solid to validate the topics that was taught to both groups by making the chart of specification, and by considering the technique of paper setting for different understandings, for example 15% for difficulty, 70% for average, and 15% for easy levels. This instrument was validated by three independent experts (three Professors, two of Mathematics education and one of educational measurement and evaluation). Although the items of the instruments above were in three categories, they were all objective questions and carried equal mark each. Based on the suggestions of these experts, the necessary corrections were made especially similar questions removed, questions reframed to avoid confusing language and properly formatted.

Pilot Testing

Pilot study was conducted in order to ascertain feasibility of conducting the present study and provide ground for the real study. International Secondary School of the Abubakar Tafawa Balewa University Bauchi's SS II students were used for the pilot study. The pilot study involved a group that had the same characteristics with the research sample, but not necessarily involved in the main study [22].

Reliability of the Instrument

The Geometry Performance Test (GPT) composed of 76 items in various difficulty levels from five areas of senior secondary school geometry was used and had reliability coefficient of 0.86 using split-half (odd-even) method. In this method the score obtained from each individual was divided into two groups by pooling the odd number items and even number items, ranking them and obtained the sum of the squares of the deviation of the ranks. Spearman-Brown prophecy method was applied to find out the coefficient of reliability from the comparable values of the post-test at 0.5% levels of significance.

Items analysis

The Geometry Performance Test (GPT) composed of 76 items in various difficulty levels from five areas of secondary school geometry was used. The Researcher prepared a thorough study on, lateral and surface areas and as well volumes of solid to validate the topics that was taught to both groups by making the chart of specification, and by considering the technique of paper setting for different understandings, for example 15% for difficulty, 70% for average, and 15% for easy levels. The following formula is used to find difficulty level.

D. L= $\frac{Ru+Rl}{Nu+Nl}$ Where,

R_u = the number of students in the upper group who responded correctly

R_l = the number of students in the lower group who responded correctly

N_u = Number of students in the upper group

N_l = Number of students in the lower group

The Geometry Performance Test (GPT) comprised of 76 items drawn from WAEC, NECO, JAMB and other relevant past questions. These were validated by three experts (professors in the Faculty of Education) and subsequently pilot tested with reliability coefficient of 0.86. A total of 86 objective type items validated to 76 items were constructed from five units of mathematics (geometry) syllabus depicting the SS II curriculum by Nigerian Education and Research Development Council (NERDC) reflecting the objectives of the programme in conformity with the Blue-print of the table of specification. In order to facilitate objectivity in scoring, the **76** validated items that constituted the Geometry Performance Test, scoring keys were prepared separately for Multiple Choice Questions, Fill in the Blanks and True and False Questions.

Administration of Treatment

The study involved three operational stages as identification stage, treatment stage and post-testing stage. The first stage involved pre-testing of all the students of both groups on intelligence and academic performance in geometry. The second stage involved the experimental treatment, which consisted of five subunits of senior secondary geometric mathematics, that is; cuboids, cylinder, cone, sphere and hemisphere taught through ICT-based teaching and through traditional teaching to control group for six (6) weeks. The third stage dealt with post testing and post-post testing of the control and experimental group using the Geometry Performance Test to determine the effect of the treatment on the students' academic performance and retention ability in geometry.

The material used for the control group was a comprehensive lesson plans from the senior secondary school mathematics curriculum and that of the experimental grouped involved ICT facilities like LCD projectors, slide screens, laptops computer and with the help of MS Animation Clips the researcher presented content specification prepared on PowerPoint application slides. The Figure 3.2 showed the flowchart of the steps of the treatment presentation even as prepared in detailed presentation plan.

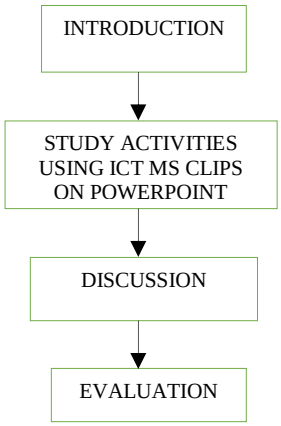

Figure 3.2: Flowchart ICT Model. Source ([23], [24]).

Data Collection Procedure

The researcher sought permission from the Bauchi state Ministry of Education to conduct this research, and the approval was given. The researcher taught both the control and the experimental groups on areas, (curved, lateral surface, total surface area) volumes and other parameters of the solid shapes popularly known as mensuration and the treatment of the Geometry Performance Test (GPT) was administered to both experimental and control groups for six weeks and all the tests conducted within the period of eight (8) weeks. The tests scores obtained from pretest, post-test and post-post-test were recorded accordingly and formed the data tabulated for analysis.

Procedure for Data Analysis

To achieve the objectives of the study, the data collected were statistically analyzed using the following techniques: t-tests and two-way ANOVA. In a nutshell, the t-test of independent samples was used to determine whether there was probably a significant difference between the means of the independent samples.

IV. RESULTS, ANALYSIS AND DISCUSSION

The results obtained from the analysis of the data collected and the discussion of the results are presented. The data collected was analyzed using standard statistical package.

Results Presentation and Data Analysis

The major objective of the study was to test the effectiveness of the ICT- used teaching method on the academic performance in geometry of secondary school students. The presentation of data, analysis and interpretations are organized around the research questions and hypotheses of the study. The treatment of the Geometry Performance Test (GPT) for the 128 sampled students was administered to both experimental and control groups within the period of eight (8) weeks. The test scores collected from pretest, post-test and post-post-test were recorded accordingly and formed the data tabulated for the following analysis using relevant statistical techniques. The variables studied in this research are; students' performance, student's retention ability and the gender differential effect of the ICT teaching method. The descriptive statistics on each of the research questions are as follow:

One: ICT performance in geometry between Experimental group and Control group.

Table 4.1: **Descriptive Statistics on the Mean of Students' Academic Performance Scores in Geometry Taught Using ICT and Lecture Method.**

Groups	N	Mean	Std.dev	Std. Err	Mean Diff.
Control	54	36.85	7.17	0.98	9.35
Experimental	74	46.20	3.69	0.43	

The results in Table 4.1 showed that the students exposed to lecture and experimental methods had their calculated academic mean performance as 36.85 and 46.20 respectively, indicating a mean difference of 9.35. The significance of this difference were shown at the test of the hypothesis.

Two: Retention level on the ICT PowerPoint animation method and lecture method.

Table 4.2: **Descriptive Statistics on the Mean Retention Ability of Students in Geometry Taught Using ICT and Those Taught Using Lecture Method.**

Variable	Groups	N	Mean	Std dev	Std. Err	Mean Diff.
Retention Ability	Control	54	36.00	7.32	1.00	4.89
	Experimental	74	40.90	9.14	1.06	

The results in Table 4.2 showed the students exposed to lecture and experimental methods and their calculated mean retention ability were 36.00 and 40.89 respectively, indicating a mean difference of 4.89. Although this showed a higher value, the

decision and significance of the difference could only be determined by the test of the hypothesis.

Test of Hypotheses

In order to find out the relative effectiveness of ICT-used method and Traditional method of teaching, the scores of students on criterion measures were obtained before commencement of the experiment and after the treatment. Post post-test scores were also obtained to determine retention ability of the students. The hypotheses were tested as follows;

Hypothesis One: There is no significant differences in the mean of students' academic performance scores in geometry taught using ICT and those taught using lecture method.

Table4.5: **Independent t-test Statistic Differences in the Mean of Students' Academic Performance Scores in Geometry Taught Using ICT and Lecture Method.**

Groups	N	Mean	Std. dev	Std. Err	Df	t cal	t-crit	Sig (p)
Control	54	36.85	7.17	0.98	126			
Experimental	74	46.2	3.69	0.44		9.62	1.96	0.001 *

Calculated p < 0.05, Calculated t > 1.96, * = Significant at p ≤ 0.05

The Table 4.5 showed the results of the independent t-test statistic which showed that significant differences exist in the mean of students' academic performance scores in geometry taught using ICT and those taught using lecture method. The reason being that the calculated p value of 0.001 was lower than the 0.05 alpha level of significance. Their calculated mean academic performance were 36.85 and 46.20 by students taught geometry using lecture method and those taught geometry using the ICT method respectively, indicating a mean difference of 9.35. This showed that students taught geometry using the ICT has significantly higher academic performance than those taught using lecture method. Consequently the null hypothesis which state that there is no significant differences in the mean of students' academic performance scores in geometry taught using ICT and those taught using lecture method, was hereby rejected.

Hypothesis Two: There is no significant differences in the mean retention ability in geometry taught using ICT and those taught using lecture method.

Table 4.6: **Independent t-test Statistic Differences in the Mean Retention Ability of Students in Geometry.**

Groups	N	Mean	Std. dev	Std. Err	Df	t cal.	t-crit	Sig (p)
Control	54	36.00	7.32	1.00	126	3.25		
Experimental	74	40.89	9.14	1.06			1.96	0.001 *

Calculated p < 0.05, Calculated t > 1.96, * = Significant at p ≤ 0.05

The results in Table 4.6 of the independent t-test statistic showed that significant differences exist in the mean of students' retention ability of students taught with using ICT and those taught using lecture method. The reason being that the calculated p value of 0.001 is lower than the 0.05 alpha level of significance. Their calculated mean retention ability were 36.00 and 40.89 by students taught geometry using lecture method and those taught geometry using the ICT respectively, indicating a mean difference of 4.89. This shows that students taught geometry using the ICT has significantly higher retention ability than those taught using lecture method. Consequently, the null hypothesis which stated that there is no significant differences in the mean retention ability of students in geometry taught using ICT and those taught using lecture method, was hereby rejected.

Summary of Major Findings

Four research questions were formulated, answered by descriptive statistics and their corresponding hypotheses were tested at 0.05 level of significant. Independent t-test and two-way ANOVA were the statistics employed for the work. Based on the analysis of data and interpretation of results, a set of findings and conclusions can be drawn and on the basis of their discussions, a wide range of implications and suggestions were focused on for further research in the field related to this study. Some of the significant findings of this research are as follows.

1. The results arrived at during this study showed that the post-test performance means scores of experimental group and control groups, matching on their treatment geometry performance differ significantly in favour of the experimental group. This implies that the students who were taught using ICT method of teaching showed significant improvement in their performance in mathematics than the students who received instruction through the traditional lecture method. It suggests that ICT used teaching method contributes towards raising the performance of students in Mathematics (geometry).

2. The group of students taught through ICT-used method, showed significantly higher means gain in performance than the group of students taught through lecture method.

3. The group of students taught geometry using the ICT method has significantly higher retention ability than those taught using lecture method.

Discussions

The major discussions emanating from the results of this study are anchored on the views of some of the researchers considered in the literature review of this work, many of which argued against the supper effect of ICT method while others are in support. These discussions are based on the findings on the variables of this study, that is; the learning strategy, especially ICT used strategy; the learning outcomes in terms of performance or achievement; the retention level measured by the post post-test among others.

In Table 4.1 and 4.5, the result showed that there was significant difference in the geometry performance at the senior secondary level between the control and experimental groups in favour of the experimental group, meaning that the findings were in agreement with that of; [25] who conducted a research on the feasibility of teaching and assessing STM with ICT in Nigeria. [10], comparing the effectiveness of *hypermedia* to traditional lecture for graduate students studying safety and industrial hygiene, in retention to the topic of instruction noise and hearing conservation. [11] too found that *hypermedia* tools offer new methods for structured discovery, address varied learning styles, motivate and empower students and allow educators to present information as a web of interconnections rather than a stream of facts. [12], comparing the geometry performance of two groups of pre-service elementary teachers enrolled in a mathematics methods course. [12], comparing the geometry performance of two groups of pre-service elementary teachers enrolled in a mathematics methods course. [13], presenting nine exercises on using different technological tools – GSP one of them – in explaining *Calculus* Concepts. These are pointers that the present study is of great impact in the teaching and learning of mathematics, moreover the only way to justify any investment either by government or public private is good performance in subjects of endeavor in which mathematics is paramount.

Nevertheless, [15], exposed ninth graders enrolled in algebra classes with traditional instruction to one of three conditions: (1) a control group; (2) a Placebo condition, where students were given a computerized word problem environment without active tutoring; and(3) an experimental group that received a computerized word problem environment with native tutoring, found that students who received *computerized tutoring system performed* better both on abstract and concrete reasoning word problem tasks than their age- mates in the other two conditions. However, they did not do better than students given human tutoring as a supplement to traditional instruction. Notwithstanding its limitations, the study provided limited support for the argument that the use of computer tutorial programs has the potential to help students with problem solving skills, which is a concrete position that this research justifies.

In Table 4.2 and 4.6, the result showed that students taught geometry using the ICT has significantly higher retention ability than those taught using lecture method. The finding was in agreement with what many researchers have posited such as; [19] who identified over 200 published texts dealing with the use of ICT in science education from 1994 to 2002 and concluded that teacher educators are unfamiliar with the literature that has been published because it is situated in journals that are not familiar to most science educators. [20] who reported that developmental mathematics students at a community college learned significantly more from an-hour *animated software* tutorial on *matrix Algebra* than from a *static one*. Animation used mostly to highlight symbols, objects, and "Morphing of addition elements and multiplication factors into sums and products." equally had a *positive impact* on content retention for students in this study.

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[21] however, in comparing the effects of three instructional approaches for teaching college-level lessons in human resource development; that is, conventional lecture-demonstration*;* interactive video with students handling the computer controls; and interactive video with the instructor handling the computer controls found no significant achievement

differences between students though both videodisc approaches resulted in significantly higher levels of student achievement than conventional instruction in a test of initial learning and a delayed test to measure retention.

The present study has generated some interesting findings concerning the benefit of using ICT in teaching a Mathematics topic as compared to the traditional lecture method of teaching. Results indicated that ICT used method of teaching significantly improved students' performance on the performance test and their retention level in answering the questions after this intervention. However, there were significant differences in students' performance and retention level when the students who were taught using ICT were compared to those taught using traditional methods. ICT-used method of teaching seemed to be very effective in enhancing students' conceptual understanding as well as improving their retention level which is a sign of the effectiveness and uniqueness of the special features in PowerPoint animated presentation programme. It can, therefore, be inferred and summarized that ICT-used teaching strategy is effective for the teaching of Mathematics.

V. CONCLUSIONS AND RECOMMENDATIONS

It may be concluded from the findings of this study that

1. ICT used teaching strategy significantly improved students' performance on the performance test and their retention level also proved that learning through ICT proves more meaningful and effective than the traditional classroom strategy.
2. Although significant differences have been found within the two groups, it is noteworthy to point out that the retention and performance of the students taught using ICT outweighed those taught using conventional method, hence ICT be used to teach mathematics particularly geometry.

The fundamental variables of the study included: (1) The learning strategy, especially ICT used strategy; (2) the learning outcomes in terms of performance; (3) the retention level measured by the post post-test questions were all significantly in favour of ICT use.

Contributions of Study to Knowledge

The study showed that ICT has portrayed an alternative and more effective teaching and learning tool in mathematics education. The study showed that students can indeed develop deep understanding that does not fade over time. Computer animations actively engage students in the learning process. Other researchers can adapt or adopt as the case may be the PowerPoint animation package developed with many adapted images to teach geometry.

The findings of the study have added frontier knowledge to the existing literature. The ICT method provides the three-dimensional pictures of the content to motivate the students and to satisfy the queries and curiosity about various scientific concepts, which a teacher may generally fail to do in the classroom teaching. While mathematics is strongly related to abstractions that require particular representations or forms that allow students to relate concepts to what they already know, teachers need to know how to translate these abstractions into understanding representations.

The findings were to established that the use of ICT particularly in teaching geometry has enhanced students' academic performance and retention ability of many senior secondary school students in Bauchi state. ICT can have a positive effect on students' motivation on their attitude toward technology, instruction and the subject matter they are expected to learn and absorb. The study revealed that changing from a traditional lecture method to an ICT used teaching method did not simply enrich class room teaching, it also significantly improved their performance.

These all imply that ICT used teaching strategy proves to be more tangible in its effectiveness on performance than the traditional classroom approach. It seems more practical and is widely acceptable to students and has no repute for individual differences and enables all types of students to perform better. In a nutshell, ICT is gradually growing a loft to provide anchorage to prop up the process of schooling in quite a big way. It is high time for the teachers, teacher educators and the teaching–learning community to make the best use of technological inputs, as available, to improve the quality of schooling at all levels and in turn raise the quality of life of the people in knowledge society.

Recommendations

Based on the findings of the study, the following recommendations are therefore made:

1. Relevant curriculum should be developed by the Nigerian Educational Research and Development Council (NERDC) to integrate ICT applications in all levels of mathematics teaching in secondary schools
2. The government in partnership with private and non- governmental organizations should provide the ICT facilities like LCD projectors, slide screens, laptops and improvise for alternative source of power supply like solar panels for consistence power supply in schools since the use of ICT depends largely on power.

3. Bauchi state ministry of education should organize mathematics teachers' forum and workshop periodically (during long vacation or at the end of each term) to share updates and development on this strategy to enhance teaching capability.
4. The ministry of education, in Bauchi state should train teachers on the use of ICT to teach other science based subjects such as Biology, Chemistry and Physics among others in secondary schools.
5. Textbook writers should include ICT as formal approach for teaching geometry (mensuration) in their materials.
6. Challenge Your Disabilities Programme (CYDP) unit of Bauchi, might find the method more interactive for better performance in mathematics to the hearing-impaired students such as dump and deaf but with sight.

Limitations of the Study

The following are the limitations of the studies;

1. This study was carried out in Bauchi State metropolis only and consequently does not permit generalization for the population of class students in Nigeria.
2. Insufficient time allocation by the Ministry of Education (four weeks) and the school time table (four periods of 35 minutes per week as against five period of 40 minutes) as a result of other newly introduced core subjects, although the school principals permitted extra afternoon and Saturday classes when they discovered the students' willingness in the programme. All of these posed some challenges to the time spent for the research.
3. The research was conducted in schools where inadequate power supply and equipment hindered full maximization of the strategy, although power generator and other equipment were made available by the researcher, the situation could have been made better.

Suggestions for Further Studies

The following suggestions are offered for further research investigations:

1. There is need to compare or study the integrated effect of ICT-used method with other institutional treatments and methods. Hence, further researches be done with ICT.
2. ICT teaching modules should be developed and extended to other subjects other than Mathematics for the purpose of comparative performance index computation. There may have been some use of ICT in other subjects but application across the curriculum was still largely undeveloped.
3. Further research could be needed to study the effect of ICT on special groups of students such as gifted, the learning disabled and other mildly handicapped.

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