

Efficacy of the Use of Information and Communication Technology (ICT) on Students' Achievement in Geometry

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Abstract

The study investigated the efficacy of the use of ICT on students' achievement in Mathematics (Geometry). The study employed a quasi-experimental design, specifically the pre-test, post-test non equivalent control group design. Two research questions and two hypotheses guided the study. The sample size of eighty (80) JSS3 students obtained from two intact classes randomly sampled from two secondary schools in Nsukka Local Government Area were used for the study. The instrument used for data collection was Geometry Achievement Test (GAT). The data collected were analyzed using mean and standard deviation for answering the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The findings revealed that students taught geometry using ICT tools performed better than students taught using conventional method; male and female students performed equally when taught geometry using ICT tools. Based on the findings, it was recommended that the teaching and learning of geometry in Junior Secondary Schools should be conducted in a manner that both teachers and the students will be actively involved (like when ICT is used) in the teaching and learning process; in-service training, workshop and symposia should be organized and made compulsory for practicing teachers to help them become aware of efficacy of the use of ICT tools in teaching and its efficacy, especially in helping students to achieve highly in geometry.

Keywords: ICT, Mathematics (Geometry), Students' achievement, male and female.

Introduction

Mathematics is the base and foundation of science and technology. It is an abstract science of numbers, quantity and space which has some branches like arithmetic, algebra, trigonometry, geometry among others. It is studied either as abstract concept (pure mathematics) or as applied to other disciplines such as physics and engineering (applied mathematics). Mathematics is a field of study that comprises of various areas, some of which deals with abstract concept which cannot be easily related to our day to day experience. These abstract concepts need to be clearly explained and followed step by step by the teachers to ensure proper understanding of the said concept. Mathematics like every other field of study is built upon fundamental laws and principles and once a student of mathematics has a weak foundation on the basic principles, it becomes difficult for such a student to understand the subject (Mohammed & Luka, 2009).

The importance of mathematics cannot be over emphasized, in that mathematics is a central issue for educationist and it is most applicable to every discipline. Everybody's needs are involved in

mathematics process every day. Mathematics is already playing an important role in the field of engineering, science, medicine, and computer, in fact in everyday life (Douglas, 2007). Mathematics is used throughout the world as essential tools in many fields, natural science, social science etc. and this is one of the reasons why higher institutions in this country place emphasis on credit pass in O' level mathematics before they offer provisional admission to the candidates into a good number of disciplines.

Despite all the emphasis placed on the importance of mathematics, one observes that students still perform poorly in the subject. The students' performance in general mathematics in the West African Examination Council (WAEC) shows that 26.01% out of the entire population of the candidates have credit pass in general mathematics (WAEC, 2007). Poor achievement in mathematics can be attributed to many factors such as poor method of teaching, unavailability of laboratory facilities, lack of instructional materials, inadequate time allocation and large class size. According to Etukudo (2009), poor achievement in mathematics is incontrovertibly attributed to poor instructional delivery approach adopted by teachers in schools. Nworgu (2009) stated that science instruction should be child centered and teaching and learning should be interactive process involving both the teacher and the students. In this case, Nworgu affirmed that knowledge is being constructed by the learners in a bid to interact their experience into the existing knowledge structure in their memory. Mathematics as a science subject should be taught in this way as above especially geometry which ran across many levels (primary, secondary and tertiary) of education.

Geometry is one of the areas in mathematics that students find difficult. Geometry refers to the branch of mathematics that treats the measurement, relationship and properties of point, lines, angles and figure in space (Houghton, 2005). Geometry is the bedrock of engineering and technological development. The WAEC Chief Examiners (2004, 2005 and 2006) consistently reported candidates' lack of skill in attempting all questions asked in general mathematics. WAEC Chief Examiner's report (2005 and 2006) further observed that candidates were weak in geometry of circle and 3-dimensional problems, where they attempt geometry questions; only few of the candidates showed a clear understanding of the questions. The weakness in geometry shown by students may be due to teacher's non-use of instructional materials in teaching the concept among other factors.

The use of instructional materials will make lesson practical and interactive and hence the students understanding of the concept will be clearer. The instructional material such as Information and Communication Technology (ICT) tools and infrastructures may afford the students the opportunity to acquire the necessary knowledge. Solarin (2012) observed on a general note that secondary schools lack facilities and equipment for teaching. According to Solarin such a situation where teachers are forced to use chalk and talk method to teach practical aspect of the subject is not good enough.

Information and Communication Technology (ICT) is the use of computers, electronic and telecommunication equipment to process, store and retrieve, analyze and disseminate information in digital and other forms. It encompasses computer hardware, software, the network and other digital devices as video, audio and camera which convert information, images, sound, motion, data and text into digital forms. Gusen (2009) viewed ICT as the combination of computer and telecommunication system to process, store, retrieve and communicate information with text, images and sound. Ibe-Bassey (2011) described ICT as critical tool for preparing and educating students with the required skills for the global workplace.

Information and communication technology is a viable tool for promoting the standard of any nation. Ijeoma (2012) asserted that ICT can enhance the quality of education in several ways; by increasing learner's motivation and engagement, by facilitating the acquisition of basic skill and by enhancing teacher training. The integration of ICT in education creates a new environment that engages the learner actively in the process and this result to a meaningful learning. The teacher as the implementer of the curriculum content and polices is the one who exploits the technologies and makes the process a success. ICT enhances teaching and learning as it involves the usage of variety of tools

to enhance and facilitate teachers' pedagogical activities through its dynamic, interactive, flexible and engaging content. The Federal government of Nigeria realizing the potential of ICT in fostering the quality of education delivery, in her policy statement has integrated ICT in education system right from the basic education level. This is because in teaching and learning, ICT materials plays a key role towards concretizing learning and may help to improve students' academic achievement. The ICT materials which can be used in the teaching and learning of geometry are of two dimensions: Hardware dimension and Software dimension

The hardware dimension comprises of all the necessary physical (tangible) material or equipment used as an ICT component like the monitor, the projector, the micro phone, central processing unit (CPU), the keyboard of the computer, mouse of the computer etc. These can be broadly divided into two categories: the projected media materials and non projected media materials. The projected media are those materials through which images of all sort are displaced by means of light and electrical wave made visible on screen or monitor, examples the television, projector, laptop etc. These projectors can be used during teaching learning situation to display both life and animated images of various illustration in geometry and step by step written analogies of teaching in geometry available to the teacher and the learner. However the non-projected media are those materials that can be used to produce illustration or graphical material like pictures, charts, maps, graphs etc.

The software dimension on the other hand refers to the virtual or in most cases the immaterial part of the ICT component which works in an integrative way with the hardware to collect, analyze, process and transmit artificial intelligence in the hardware, which controls their activities in producing the desired media effect from them. They can be inform of programme installed into computer system, film strips in projector, without these, hardware will be useless in ICT instructional materials to the teacher and learner. All these are of great relevance to mathematics education and they include the power point, coral draw, spread sheet, Computer Assistant Instruction (CAI) (Johnson, 2002). When all these relevant materials to mathematics education are used in teaching and learning of mathematics concepts like geometry it is hoped that it may help to increase the students' clearer understanding of the concept and hence their achievement in mathematics.

Achievement in mathematics refers to an accomplishment which is shown by scores. It is the ability to retain and subsequently remember things experienced or learned by an individual at a time. Qualitative mathematics education can be evident in students' academic achievement, emphasize their knowledge, comprehension and application levels in mathematics. Students' achievement in geometry can be measured by examination or continuous assessment. According to Aremu and Sokan (2003) secondary education is the foundation level for further education and if a poor foundation is laid, there is likely going to be problem at subsequent levels. Achievement in mathematics for candidates who sat for Senior Secondary Certificate Examination [SSCE] or Junior Secondary School Certificate Examination (JSSCE) is said to be good when the pass is at credit level and above. But students' achievement for both certificate examinations above have fallen short of being good as the percentage credit pass for years is less than 40%. This poor achievement is experienced by both gender [male and female] as there can be differential performance in mathematics according to gender.

Gender is a factor that has been considered by many researchers in the study of mathematics. Gender is a state of being male or female (typically used with reference to Social and Cultural differences rather than Biological ones). Thus, gender is a social or cultural determinant that varies from place to place or from culture to culture. It is different from sex because sex is a biological construct and is universally the same. Babajide (2010) opined that science subjects especially mathematics are given masculine outlook by educational practitioners. No wonder Agomuoh (2010) opined that gender influence students' performance. In another report, WAEC (2000-2011) chief examiners reports confirmed that boys performed better than girls in mathematics. Contrary to this report, Gimba (2006) found that female students performed better than male students when exposed to geometry using instructional materials. Some other researchers like Spencer (2004) and Iwendi (2012) found no gender difference in the performance of male and female students in school mathematics.

Also, Mberekpe (2013) discovered that there was no significant difference between the mean score of male and female students when taught using student's improvised instructional material. From these reports above, it could be seen that the issue of gender is still inconclusive as regards to achievement, hence this study sought to examine the efficacy of the use of ICT on male and female students' achievement in Geometry.

Statement of the Problem

Geometry which is the bed rock of engineering and technology development has recorded persistent poor performance by students in internal and external examinations. It has been observed that candidates were weak in geometry of circle and 3 dimensional problems and hence achieve poorly in it. This poor achievement in geometry generally has been attributed to many factors such as poor method of teaching, unavailability of laboratory facilities, lack of instructional materials, and lack of ICT tools and even non utilization of the few available materials/tools. Consequently the students' achievement in mathematics has been poor and as a result cannot produce competitive workers who can match global market demands in this technological era. Therefore there is need to improve students' achievement in mathematics in order to produce highly qualified personnel in mathematics who can compete favorably with others in the global digital world. One of the intervention measures which may help to improve mathematics achievement of junior secondary school students in the use of ICT materials in teaching and learning of mathematics. This study therefore sought to establish the efficacy of the use of ICT tools on students' achievement in geometry in junior secondary school.

Purpose of the Study

The main purpose of this research is to determine the efficacy of the use of ICT on students' achievement in geometry. Specifically, this study is aimed at:

1. determining the efficacy of ICT materials on students' achievement in geometry
2. determining the influence of gender on the mean achievement scores of students in geometry.

Research Questions

The following research questions have been posed to guide this study.

1. What are the mean achievement scores of students taught geometry with ICT materials and those taught without ICT materials (that is conventional method).?
2. What are the mean achievement scores of male and female students taught geometry using ICT materials?

Hypotheses

The following null hypothesis were formulated to guide this study and tested at 0.05 level of significance.

H₀₁: There is no significance difference in the mean achievement scores of students taught geometry using ICT materials and those taught geometry without ICT materials.

H₀₂: There is no significance difference between the mean achievement scores of male and female students taught geometry using ICT.

Methodology

This study employed the quasi-experimental design. Specially, the pretest, posttest non-equivalent control group design was used. Quasi-experimental design is considered appropriate for the study because intact classes were used to avoid disruption of normal class lesson.

The population of the study consists of all the JS3 students in all the 43 junior secondary schools in Nsukka local government area (Post Primary Schools Management Board (PPSMB) Nsukka, 2018). The sample size of this study is eighty (80) JSS3 students from two intact classes in two public coeducational secondary schools in Nsukka Local Government Area. One intact class from each co-educational secondary school was randomly selected to represent the experimental and control groups.

The instrument for data collection was Geometry Achievement Test (GAT). Two lesson plans were also used in teaching the geometry concepts. The GAT consist of two sections, section A consists of information about the students while section B consists of thirty (30) multiple choice questions drawn from the four topics on geometry (2-dimensional shapes, 3-dimensional shapes, Angles and Construction of angles) taught. The instrument was face and content validated by experts from mathematics education and measurement and evaluation all from Department of Science Education, University on Nigeria, Nsukka. Their comments and suggestions were used in restructuring the test items that appeared in the final draft of the instrument. GAT was subjected to reliability analysis by the researchers using Kuder-Richardson (K-R20) formula. The reliability estimate was 0.78

The students were given the GAT as pre-test. Subsequently, the researchers taught the control group without using ICT materials (conventional methods) while the experimental group was taught using ICT materials, after the teaching. The posttest which is a re-organized form of pre-test was administered to both experimental and control groups. The data collected were analyzed using mean and standard deviation to answer the research questions while ANCOVA was used to test the hypotheses at 0.05 level of significance.

Results

Research Question One

What are the mean achievement scores of students taught geometry with ICT materials and those taught without ICT materials?

Table 1: Mean and Standard Deviation of Scores of Students Taught Geometry with ICT Materials and those Taught without ICT Materials in GAT.

Group	N	Pre-test		Post-test		Mean Gain
		Mean	Std. Deviation	Mean	Std. Deviation	
Control group	40	11.80	5.91	14.60	2.44	2.80
Treatment group	40	11.20	2.45	24.40	4.84	14.20
Mean Difference		0.60		9.80		

From Table 1, the mean in pretest for the control group is 11.80 while the mean in the pretest for the treatment group is 11.20 which gave a mean pretest difference of 0.60. For the posttest, the mean for the control group is 14.60 while the mean for the treatment group is 24.40. It appears that the students taught geometry using ICT materials performed better than those taught using conventional method though the scores was not very high.

Research Question Two

What are the mean achievement scores of male and female students taught geometry using ICT materials?

Table 2: Mean and Standard Deviation of Male and Female Students Taught Geometry Using ICT Materials.

Group	N	Pre-test		Post-test		Mean Gain
		Mean	Std. Deviation	Mean	Std. Deviation	
Male	17	12.10	3.91	20.40	5.44	8.30
Female	23	11.90	3.45	20.10	5.35	8.20
Mean Difference		0.50		0.30		

From Table 2, the mean in pretest for the male is 12.10 while the mean in the pretest for the female is 11.90 which gave a mean pretest difference of 0.50. For the posttest, the mean for the male is 20.40 while the mean for the female is 20.10 with a mean difference of 0.30. It appears that male students had slightly higher post-test mean achievement score when compared with their female counterpart in geometry teaching using ICT materials.

Hypothesis One

There is no significant difference in the mean achievement scores of students taught geometry using ICT materials and those taught with conventional method.

Table 3: Analysis of Covariance (ANCOVA) for Students Taught Geometry with ICT Materials and those Taught without ICT Materials.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1050.400 ^a	2	525.200	61.422	.000
Intercept	269.120	1	269.120	31.474	.000
Test	627.200	1	627.200	73.351	.000
Group	423.200	1	423.200	49.493	.000
Error	658.400	77	8.551		
Total	17840.000	80			
Corrected Total	1708.800	79			

a. R Squared = .615 (Adjusted R Squared = .605)

The results in Table 3 shows that the f-ratio is (49.49) at $p < 0.05$, hence there is a significant difference at 0.05 level of significance in the post test mean scores of the control group and the treatment group. Therefore, the null hypothesis which states that there is no significant difference between the mean scores of the students taught geometry using conventional method and students taught using ICT materials was rejected. It implies that students taught using ICT materials achieved higher than their counterparts taught using conventional method.

Hypothesis Two: There is no significant difference in the mean achievement scores of male and female students taught geometry using ICT materials.

Table 4: Analysis of Covariance (ANCOVA) for Male and Female Students Taught Geometry using ICT Materials.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	33.383 ^a	2	16.692	.780	.462
Intercept	225.404	1	225.404	10.528	.002
Test	6.933	1	6.933	.324	.571
Gender	2.051	1	2.051	.096	.758
Error	1648.567	77	21.410		
Total	30638.000	80			
CorrecteTotal	1681.950	79			

a. R Squared = .020 (Adjusted R Squared = -.006)

The results in Table 4 shows that the f-ratio is 0.096 at $p < 0.05$, hence there is no significant difference at 0.05 level of significance in the post test mean score of male and female students. Therefore, the null hypothesis which states that there is no statistical significant difference between the mean scores of male and female students taught geometry using ICT materials is upheld. It implies that male and female students performed equally in geometry when taught using ICT materials.

Discussion of Findings

Result of data analysis on Table I has shown that students taught geometry using ICT tools performed significantly better in the geometry achievement test than their counterpart who were taught using the conventional method (chalk and talk method). This result is in agreement with the result of earlier study carried out by Nwokoma (2003) who found that selection of appropriate approach in teaching mathematics and use of mathematics facilities and equipment fosters students' achievement in mathematics. The relative superiority of the use of ICT on students' achievement in geometry over the conventional method in enhancing students' achievement in geometry could be attributed to the fact that as a teaching method, the use of ICT tools in teaching geometry is student-centred and ensures active participation of students in the teaching-learning process more than the conventional method. In comparing the achievement of the subjects in geometry, the mean score of the experimental groups were higher than those of the control groups. Hence, the use of ICT tools in teaching enhances students' achievement in geometry.

The finding of the study showed that the mean achievement score of male students was slightly higher than that of female students. But further analysis on this using ANCOVA revealed that there is no significant difference in the mean achievement score of male and female students taught geometry using ICT materials. The finding of this research agrees with that of Spencer (2004) and Iwendi (2012) who in their different studies found no gender difference in the performance of male and female students in school mathematics. It also corroborate with Mberekpe (2013) who discovered that there is no significant difference between the mean score of male and female students when taught using student's improvised instructional material.

Conclusion

From the result obtained in the study on efficacy of the use of ICT on students' achievement in geometry, it was found that students taught geometry using ICT tools performed better than those taught without the use of ICT tools. There was significant difference in the mean score of students taught geometry using ICT tools and those taught geometry without use of ICT tools (conventional method). Therefore, the researchers concluded that use of ICT tools is efficacious in boosting students' achievement in geometry. Male students slightly performed better than their female counterparts when taught geometry using ICT tools. But further analysis of the result shows no significant difference between male and female students when taught geometry using ICT tool. Therefore, the difference was not statistically significant. Hence, male and female students performed equally when exposed to ICT materials, therefore the use of ICT tools in teaching geometry is gender friendly.

Recommendations

Sequel to the results of the study, the following recommendations were made.

1. In-service training, workshops and symposia should be organized and made compulsory for practicing teachers, to help them become aware of efficacy of the use of ICT tools in teaching geometry and its effectiveness, especially in helping students to achieve highly.
2. Teachers should be encouraged to belong to professional bodies like Science Teachers Association of Nigeria (STAN), Mathematics Association of Nigeria (MAN) etc. where new approaches and strategies are discussed so that teachers should always update and enrich their knowledge with new technology involved in teaching and learning.
3. The Accrediting body of the federal ministry of Education should include use of ICT tools in teaching mathematics as one of the criteria for the merit of full accreditation of ICT tools as part of teaching and learning mathematics

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