

Exploring the Effectiveness of Computer ActivInspire Software on Students Academic Achievement in Mathematics

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ABSTRACT

This study explores the effectiveness of Computer ActivInspire software on students' achievement in learning mathematical concepts that have to do with graph. The research uses a Pretest – Posttest randomized equivalent group design. The population of Senior Secondary School (SSS) class 3 students is 6,147 spread across Minna Metropolis. Four schools were chosen using multistage sampling within Minna Metropolis and the sample of the study consisted of 120 randomly selected students. The experimental group was taught using the activinspire software, while the control group was taught using the conventional method. The research instrument used was the Mathematics Achievement Test (MAT). This was validated by experts and were certified to have content validity. The reliability coefficient of 0.83 was obtained. The data collected after 6 weeks of application was analysed using Analysis of Variance Statistics with the aid of SPSS Version 16.0. Two hypotheses were tested at 0.05 significant level. The results showed that there was significant difference between experimental and control groups' achievement. This difference is in favour of the experimental group which had lesson taught the ActivInspire Software. The results also showed that there was no significant difference in the achievement of male and female students taught using the activinspire software. It was recommended that Computer ActivInspire software should be explored by teachers for enhancing their teaching. The use of the computer ActivInspire software would also help in bridging the perceived gender disparity in students understanding of mathematical concepts. The government should promote the use of the software through organizing seminars, workshops and induction courses for science teachers.

Keywords: Activinspire, Mathematics, achievement, Computer software

INTRODUCTION

Mathematics is a key subject taught in all schools throughout the world due to its relevance to the development of science and technology. It is an integral part of life because it is needed by everyone for successful living (Onoshakpokaiye, 2006). Secondary school education is the bedrock of future development of the citizens in any country and the mathematics achievement at secondary school is a key predictor of a nation's long term economic potential. Mathematics is one of the key subjects which every student must offer in the senior secondary school in Nigeria, regardless of whether the student is in the science, commercial or arts class. The importance of mathematics to nation building led the Federal Government of Nigeria to make mathematics a core subject to be offered by students at all levels of education in Nigeria (FRN, 2004). A credit pass in Mathematics and English language is a must before a student can secure admission to study science or social science related courses in the university.

Despite the importance that has been placed on the studying of mathematics, in Nigeria today, the average student believes that mathematics is difficult to understand. This is then reflected by the students having little or virtually no interest in the subject and poor results or under-achievement in mathematics examinations. This trend is one of serious concern to education stakeholders, parents and the general public. Results from the national examination bodies such as the West African Examinations Council (WAEC) and the National Examinations Council (NECO) have consistently shown that students perform poorly in mathematics exams. In the analysis of the May/June 2000 West African School Certificate result, more than 50% of the candidates failed to pass mathematics at credit level and the percentage of failure among girls surpassed that of boys (Onuka, 2002). One of the factors that has been discovered to play a vital role in the support or discouragement of performance and academic achievement of students in mathematics is the teaching methods or strategies used. Ebenezer (2009) stated that teaching strategies that one uses will undoubtedly affect one's philosophy of teaching. He went further to state that Education is a cooperative enterprise that works well if the students are permitted to contribute while the teacher listen and respond. Okpala (2006) stated that "one of the important median of realizing the educational objectives is the appropriate teaching method."

There is a clear symbiotic relationship between Mathematics and the computer. The existence and process of computer has helped to develop Mathematics and make it more accessible to students (Tooke, 2001). ICT play an important role in improving the quality of education and enhancing teaching efficiency. Mathematics as with any other subject is

best learnt when students are actively involved in the learning process (i.e. student centred teaching) as it helps in increasing a positive attitude towards learning (Brewster and Fager, 2000).

LITERATURE REVIEW

Definitions of Mathematics

Odili (2006) defined mathematics as a body of knowledge, a collection of techniques and methods, and the product of human activity meant for solving problems. It is the science of sizes and numbers that has evolved from elementary practices of counting, measuring and describing the shapes of objects. Oxford Advanced Learners Dictionary (2010) defines mathematics as the science of sizes and numbers with branches such as arithmetic, algebra, trigonometry and geometry. New Encyclopaedia Britannica (2010) defines it as the science of structure, order and relation that has evolved from elementary practices of counting, measuring and describing the shapes of objects.

Reasons for students' failure in Mathematics and possible solutions

A number of factors had been identified by various researchers and educators as being responsible for poor achievement in mathematics. These include students' characteristics, instructional/classroom characteristics, teachers' characteristics, societal factors and school factors. Other factors often cited, include lack of motivation and poor self-image (self-concept) of teachers, lack of innovative teaching methods, lack of teaching facilities, poor school climate, lack of incentives and motivation, poor remuneration, poor condition of service and students' poor problem-solving abilities (Munro, 1979, as cited in Ajogbeje, 2012). Others include poor teaching approach (WAEC, 2007, Olunloye, 2010), lack of confidence in the subject (Basturk, 2005). Instructional approach employed by teachers is another important area that researchers have put their searchlight on. This is because; it can easily be manipulated to bring positive changes in learners more than other factors like gender, ability and intelligence. According to Olunloye (2010), when teachers improve their teaching methods it often leads to better understanding and application of mathematics principles among the students so that their interest could be aroused. Therefore, there is need to explore approaches that will improve students' achievement as results (WAEC, 2010) indicate that the conventional teaching approach is no longer sufficient in meeting the needs of majority of learners.

The conventional teaching approach is described as teacher centred and associated with learners simply listening, copying notes, doing class work and doing assignments. Okafor (2002) identified poor teaching methods as the major factor contributing to the poor performance of students in mathematics. In addition, Karron& Bryne (2005) discovered that in Nigeria today, teachers, textbooks, chalkboards and traditional facilities are no longer adequate to cope with the amount and type of skills and competences expected of students. Accordingly, Ogoni (2003) suggested that teachers need resources that can assist them to carry out their duties efficiently. There is also an urgent need for a shift from the lecture mode of teaching which is teacher-centred to a learner-centred mode in the classroom. Williams (2004) stated that teaching methods over the years have shown that there have been changes from one position to another, many efforts have been made to improve the teaching methods through the use of instructional materials such as the computer. Availability of many educational software enables students to have better understanding of concepts they need to know in order to be active participants in today's technologically advancing society. This gave birth to Computer Assisted Instruction (CAI).

CAI can be referred to as a self-learning technique usually offline or online, involving interaction of students with programmed instructional materials (Adeyemi, 2012). It is an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning that takes place. CAI programs use tutorials, drill and practice, simulation and problem solving approaches to present topics to the students and also to test the students' understanding. Therefore, the position of mathematics makes it necessary for the use of innovative pedagogical strategy that will enable teachers meet the challenges of teaching and learning of the subject especially in this era of information age.

Computers should be used as a material and method or as instructional materials that is effective for making students to concentrate on, understand, synthesize and improve positive attitude in pupils towards the subject of the course. An instructional material makes the topic clearer and more lasting by making the topics that are abstract for students more concrete (Demirel, 2004). CAI captures students' attention because the programs are interactive and engage the students' spirit of competitiveness to increase their scores.

CAI involves students, teachers, and administrators in the ever growing process of making schools exciting and challenging places to work and to learn. CAI's encourages students to be involved in thought-provoking activities that connect academic learning with practical, real world activities (Sherry, Billing, Jesse, & Watson-Acosta, 2001; Kadiravan & Suresk, 2003; Adeyemi, 2012)

Some of the CAI's software specifically created for the teaching and learning of mathematics includes LOGO, Coypu, Derive, and Mathematica. For example, LOGO is an open-ended, general purpose, discovery-based programming language developed to teach powerful ideas such as procedural thinking, concrete and formal operations, problem decomposition, and debugging through discovery learning in a micro world (Subhi, Papert cited in Lowe, 2004). It was also indicated that problem solving-based LOGO environment can facilitate the acquisition of knowledge in the specific domain in which children construct mathematical concepts. Advocates of CAI such as Chang (2002); Cotton (2001); Garcia and Arias, (2000) claimed that CAI improves positive attitudes of students toward learning and directly increase their achievements. The primary advantage of computer-based instruction over the traditional method in the teaching of mathematics includes its flexibility and convenience with self-paced instruction. This provides students with immediate and frequent feedback without the embarrassment that a mistake in a traditional classroom might cause. For many students who have experienced failure with traditional mathematics instruction, CAI offers an alternative to the classroom situation that did not work for them (Seese, cited in Moosavia, 2009).

Effects of Computer Aided Instruction

The primary advantages of Computer-Aided Instruction (CAI) for a student in mathematics are flexibility and convenience with self-paced instruction. This provides students with immediate and frequent feedback without the embarrassment that a mistake in a traditional classroom might cause. Other advantages of CAI include clarity and structure, impartiality, active learning and involvement and variety and appeal to those students accustomed to using computers (Capper & Copple, 1985). In addition, a student would be free to consult a teacher/lab assistant as needed for help with a challenging concept. For many students who have experienced failure with traditional mathematics instruction, CAI offers an alternative to the classroom situation that did not work for them (Seese, cited in Moosavi 2009). Based on the research reviewed, Cotton notes that students learn material in either the same time or less time when CAI is used. One study indicated by Cotton (2001) determined that students learn up to 40% faster when taught using CAI, as CAI increases student's time on a task. Computerized teaching leaves teacher more time for more creative activities, for educational activity, for pedagogical and professional training, for making a programme more innovating (DanimirMandic, 2008).

Theoretical Framework

The use of instructional technology has been supported by a number of critical learning theories. Educational theories relevant to this investigation include the social cognitive and constructivist paradigms of learning. Social cognitive theory, as advocated by Bandura and Vygotsky, believe that learning is filtered through a child's culture, both in its content and style of thinking. In the social cognitive learning perspective, students learn best in the company of others, social groups playing an influential role in the development of understanding. Pedagogically, learning is facilitated through guided instruction, problem-solving, and peer interactions. (Bandura, 1986) states that "Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do . . . most human behaviour is learned observationally through modelling: from observing others one forms an idea of how new behaviours are performed, and on later occasions this coded information serves as a guide for action". This is consistent with Vygotsky's point of view that social interactions are essential to learning. Because he believed that social exchanges are so important to learning, he advocated the designing of curricula stressing the dynamic role students must play in learning activities. He stated that "instruction is most efficient when students engage in activities within a supportive learning environment and when they receive appropriate guidance that is mediated by tools". (Vygotsky cited in Cullata, 2013) Among the tools available for implementation as cognitive strategies are computer-supported interactive whiteboard (IWB) such as the ActivInspire software. Glover, Miller, Averis, and Door (2007) stated that through the use of the IWB, teachers "become more aware of the nature of interactivity and its stimulation as the basis for conceptual development and cognitive understanding". Cognitive approaches have also influenced objectivist instructional models by emphasizing the use of advanced organizers, mnemonic devices and learners' schemes as an organized knowledge structure (Driscoll, 2000). Bosco and Morrison (2000) reported that the cognitive theory is now the dominant theoretical view point in research on learning, memory and retention. Computer-supported learning permits the construction of knowledge through collaboration and discourse

Problem Statement

A close examination of the performance of students in Niger State in the National Examinations Council Secondary School Certificate Examination (NECO SSCE) results of twelve consecutive years revealed that most students who need mathematics as part of their entry requirements would not get admission into university owing to their failure to credit mathematics (NECO SSCE, 2013). This is as a result of a lot of problems facing the effective teaching and learning of mathematics at all levels of Nigerian education (Bankolere, 2006). Okafor (2002) identified poor teaching methods as the major factor contributing to the poor performance of students in mathematics. Karron & Bryne (2005) also noted that in Nigeria today, teachers, textbooks, chalkboards and traditional facilities are no longer adequate to cope with the amount and type of skills and competences expected of students. Accordingly, Ogoni (2003) suggests that teachers need resources that can assist them to carry out their duties efficiently. There is also an urgent need for a shift from the lecture mode of teaching which is teacher-centred to a learner-centred mode in which computers are used to aid teaching in the classroom. This method of instruction enables students to have better understanding of concepts they need to know in order to be active participants in today's technologically advancing society.

MATERIALS AND METHODS

Research Model

This research uses a parallel group experimental design that examine the effects of the active inspire software on the academic performance of mathematics students in secondary schools in Chanchaga Local Government of Niger State. The parallel group experimental design is used so as to be able to compare the two equivalent groups. It was also used because the students were randomly allocated into the treatment group that was taught with activinspire software and the control group that was taught using the conventional method. Similar to the great amount of research studies on the impacts of computer assisted instruction, this study is also based on the quasi-experimental research design where the researcher analysed the effects of independent variable on the dependent variables. The computer-assisted instruction implemented in the experimental group was the independent variable and the dependent variable was the mathematical achievement of the students.

Experiment and Control Group

The purpose of the Pre-test was to determine the equivalence of both the experimental and the control groups before the application of treatment. In the analysis of pre-test data, the mean scores and the standard deviations of the experimental and control groups were computed and compared using Analysis of Variance (ANOVA). The results of the analysis are presented in table 1

TABLE 1: ANOVA for Pre-test Scores of Control and Experimental Groups

Sources of Variation	Sum of Squares	Df	Mean Square	F _{cal}	F _{crit}	Sig
Between Groups	15.987	1	15.987	.244 ^{ns}	3.92	0.622
Within Groups	7730.446	118	65.512			
Total	7746.433	119				

ns= not significant at 0.05(P> 0.05)

Table 4.1 shows the ANOVA comparison of the mean scores. The ANOVA analysis of the results indicated that there is statistical significant difference between the pre-test mean scores of the experimental group at 0.05 level of significance ($F_{cal}=0.244 < F_{crit}=3.92$; $df=1, 118$ and $p> 0.05$) and that of the control group (35.000). The pre-test results show that there was not any statistically significant difference between the groups. Therefore, the two groups were equivalent in their prior knowledge of the mathematical concepts treated in the study and so one of the groups was selected as experimental and the other as control group. The experimental group was subjected to the lessons in which the Activinspire software was the computer assisted teaching method used to teach topics in the general mathematics syllabus that have to do with graph such as the cumulative frequency curve, while the control group was subjected to the lessons taught using the lecture method.

Research Questions

The study attempts to answer the following research questions:

- i. Is there any difference in the achievement of students taught mathematics with the active inspire software and those taught with the lecture method?
- ii. Is there any significant difference between the achievement of male and female students taught mathematics using the active inspire software?

Process

Over a six weeks' period the topics quadratic graph, calculation of mode and median from histogram, calculations using the cumulative frequency curve etc. were taught using the senior secondary mathematics curriculum. Then the lessons were taught with Activinspire software for the experiment group. The Activinspire software was used to make the lessons more interesting, concrete and visual. For the control group they were taught using their mathematics textbooks and the chalkboard.

Mathematics Achievement Test (MAT)

By examining the target behaviours determined by the Nigerian Senior Secondary School Certificate syllabus for the unit trigonometric functions and graphs of trigonometric functions, determination of median and mode from ogive subtopics etc. The test involved 30 items with multi-choice questions. In line with the targets of the given units, an achievement test consisting of 30 multi-choice questions prepared by using different text books and questions previously asked in senior secondary certificate examinations was designed. The achievement test was designed to measure the objectives that the students in both groups were expected to achieve during the study

Population

Population of the study consisted of students who were in SS3 in secondary schools in Minna Metropolis. The total number of SSS 3 students was 6,147 spread across Minna Metropolis.

Sample

The sample of the study consists of 120 students from four government owned secondary schools in Minna metropolis of Niger state in Nigeria. 60 students for the experimental group while the other 60 students for the control group. The sampling was in two stages the schools were purposively sampled to select schools that had enough working computers, then random sampling of the students in those schools were carried out using the hat draw method. A total of 120 students were selected so that the number of students in both the experimental and control groups could be equivalent in keeping with the research design.

Data Analysis Techniques

With the intention of answering research questions, data collected was analysed by using descriptive and inferential statistical analysis methods. At the beginning of the study, reliability analysis was conducted to test the reliability of the achievement tests. First, the descriptive statistics was conducted to report the differences between the control group and the experimental group on mathematics achievement. Later, independent sample t-tests and Analysis of Variance (ANOVA) statistics were utilized to test the difference between pre-test and post-test of the experimental and control groups; and the post-test of experimental and control groups and the hypotheses at the level of significance $p=0.05$.

RESULT AND DISCUSSION

Figure 1 presents a picture of the pretest raw scores of the students before treatment was administered.

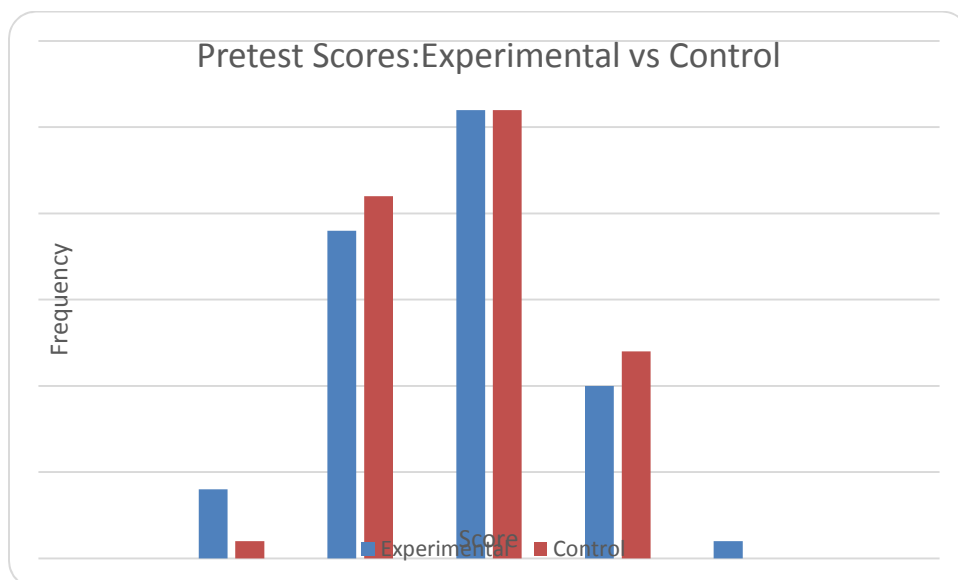


Figure 1: A chart of Pre-test raw scores of experimental and control groups

Figure 2 presents a picture of the posttest raw scores of the students after treatment had been administered

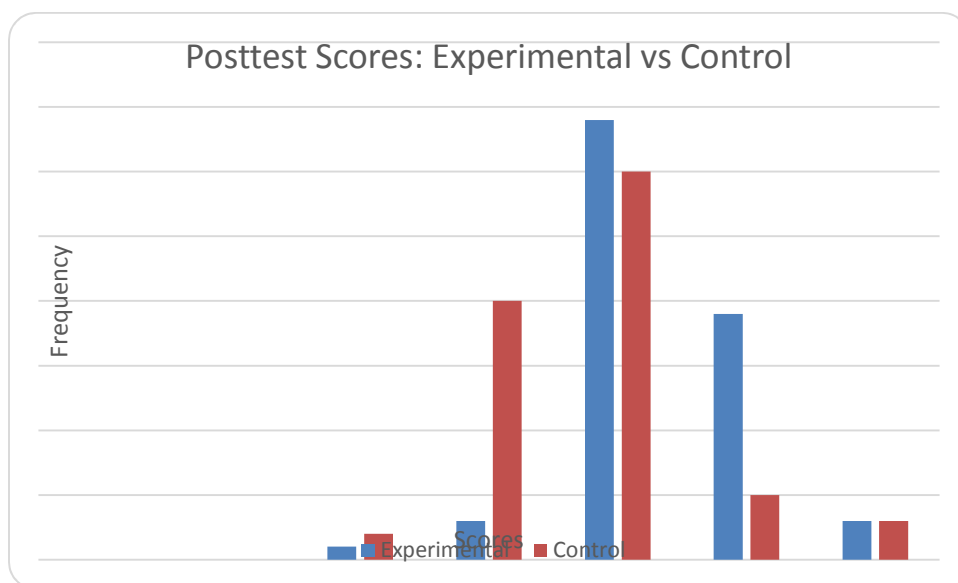


Figure 2: A chart of Posttest raw scores of experimental and control groups

Table 2. Pretest Post-test Results of Experimental Group

Test	N	Mean	SD	df	t	significant
pretest	60	34.27	1.124035	118	-10.2473	0.05
posttest	60	49.06167	0.905617			

As the Table 2 was examined, it is seen that there is a statistically meaningful difference between the students'

success points of the experimental group on the pre-test and on the post test. The origin of the difference is seen that students are more successful on post-test mean ($\bar{x} = 49.06$), than the pre-test mean ($\bar{x} = 34.27$). This finding can be interpreted that the lessons in which Activinspire software was used has a meaningful effect on students' learning.

Table 3. Pretest Post-test Results of Control Group

Test	N	Mean	SD	df	t	significant
Pretest	60	35	0.959316	118	-6.57319	0.05
Posttest	60	44.615	1.104254			

In Table 3, it is seen that there is a statistically meaningful difference between the students' success points of the control group on pre-test mean and on post-test mean. The origin of the difference is seen that students are more successful on post-test mean ($\bar{x} = 44.62$), than the pre-test mean ($\bar{x} = 35$). This finding can be interpreted that the lessons which were studied even using the lecture method had a meaningful effect on students' learning in the control group.

The purpose of the pretest was to determine the equivalence of both the experimental and the control groups before the application of treatment. In the analysis the pretest data of the experimental and control groups were computed and compared using the Analysis of Variance (ANOVA) statistics.

Table 4: ANOVA for pretest scores of control and experimental groups

Sources of Variation	Sum of Squares	df	Mean Square	F _{cal}	Sig
Between Groups	15.987	1	15.987	.244 ^{ns}	0.622
Within Groups	7730.446	118	65.512		
Total	7746.433	119			

ns= not significant at 0.05(P> 0.05)

Table 4 shows the ANOVA comparison of the mean scores. The ANOVA analysis of the results indicated that there is statistical significant difference between the pre-test mean scores of the experimental and control group at 0.05 level of significance ($F_{cal}=0.244 < F_{crit}=3.92$; $df=1,118$ and $p> 0.05$). This indicates that there is no significant difference in the mean scores of the experimental and control groups in the pretest. Therefore, the two groups were equivalent in their prior knowledge of mathematical concepts.

Table 5: Independent t-test comparing the result of the posttest results between experimental and control groups

Test	N	Mean	SD	df	t	Significant
EXPERIMENTAL	60	49.06166667	0.905616785	118	3.11366	0.05
CONTROL	60	44.615	1.104254292			

From Table 5, the result of the independent-t test comparing the post test results of the two groups showed that there was a significant difference between mean performance scores of the control group ($\bar{x} = 44.62$, $SD= 1.10$) as compared to experimental group ($\bar{x} = 49.06$, $SD= 0.91$; $t(120) = -3.11$, $p < 0.05$).

This finding indicated that students who had learned graphical concepts using Activinspire were significantly better in their achievement compared to students who were taught using the lecture method. To further confirm this, the Analysis of Variance (ANOVA) with repeated measures using the SPSS was utilized to test the hypotheses at the level of significance $p=0.05$.

In the analysis of post-test data, the scores of the experimental and control groups were computed and compared by testing the hypothesis using Analysis of Variance (ANOVA). The results of the analysis are presented in Table 5.

Hypothesis One (Ho₁)

There is no significant difference in the mean achievement scores of students taught graphical concepts in mathematics using the ActivInspire software and those taught with the lecture method.

Table 6: ANOVA for Mean Achievement Scores of Control and Experimental Groups

Sources of Variation	Sum of Squares	df	Mean Square	F _{cal}	F _{crit}	Sig
Between Groups	593.185	1	593.185	9.695*	3.92	.002
Within Groups	7219.898	118	61.186			
Total	7813.084	119				

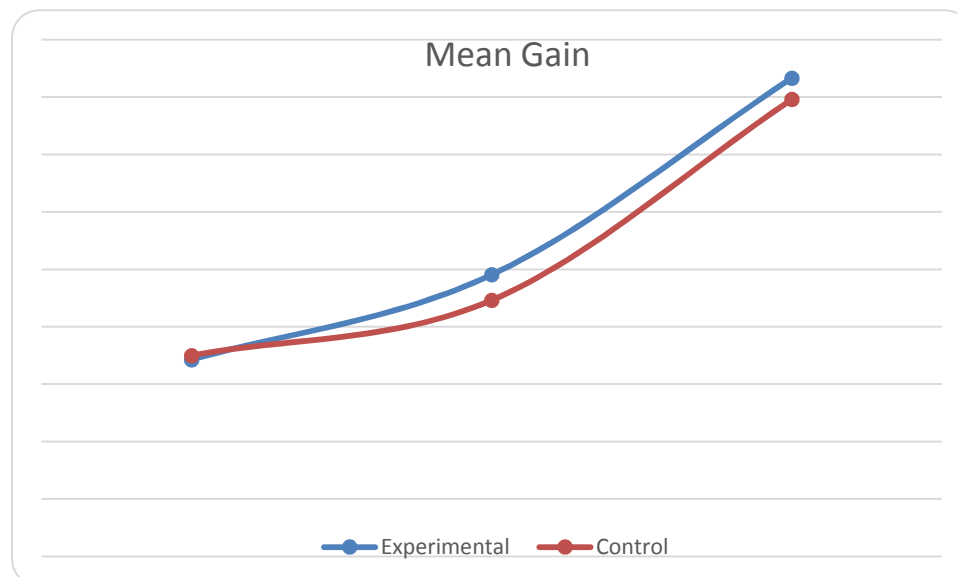
* significant at 0.05 level of significance

The Table 6 shows the ANOVA comparison of the control groups and experimental groups. The results show that there is statistical significant difference between the mean scores of the experimental group (49.0617) and control group (44.6150) at 0.05 level of significance ($F_{cal} = 9.695 > F_{crit} = 3.92$; $df = 1, 118$; $p < 0.05$). This indicates that there was a significant difference between the mean achievement scores of the experimental group and the control group at 0.05 level of significance. So, the null hypothesis is rejected. This implies that there was significant difference between the mean scores of students taught mathematical concepts using the ActivInspire software and those taught using the lecture method.

Table 7: Mean Gains of Experimental and Control Groups

	Pretest		Posttest	Mean gain
	Mean	Std deviation	Mean	
Experimental	34.27	8.70673	49.0617	14.7917
Control	35	7.43083	44.615	9.615

Table 7 shows that the experimental group has the highest mean gain of 14.7917 while the control group has the mean gain of 9.615. Therefore we could say that the treatment was responsible for the significant difference. This implies that the Computer Aided Instructional Package Activinspire software improves students' performance than the conventional method. This can be seen in the mean gain plot shown in the figure

**Figure 3:** Mean gain plot of experimental and control groups

Hypothesis Two(H₀₂)

There is no significant difference between the achievement of male and female students taught mathematics using the active inspire software

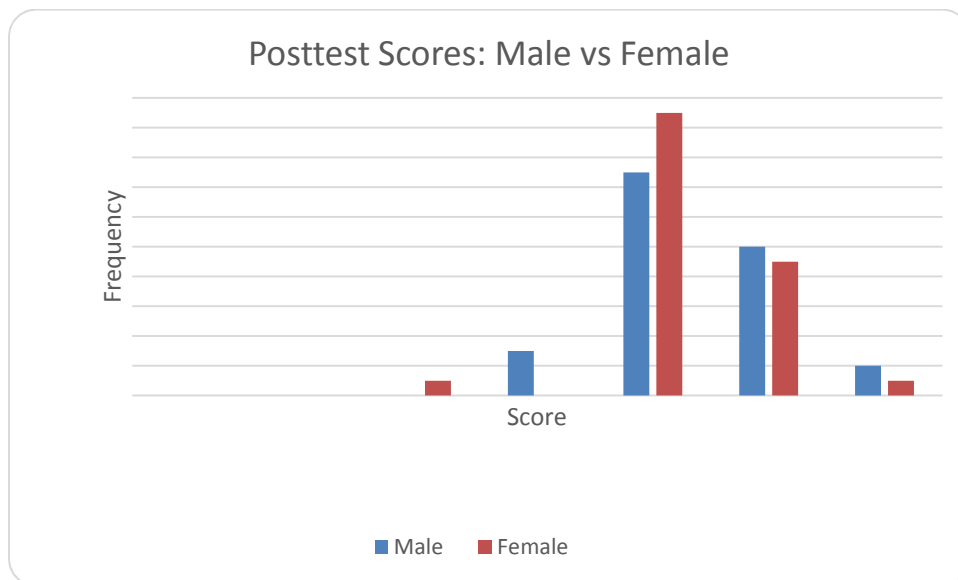


Figure 4: A chart of Post-test raw scores for male and female experimental groups

Table 8: ANOVA for post-test mean scores of male and female experimental groups

Sources of Variation	Sum of Squares	df	Mean Square	F _{cal}	Sig
Between Groups	36.660	1	36.660	.742*	.393
Within Groups	2866.642	58	49.425		
Total	2903.302	59			

*-significant at 0.05 level of significance

From the table 8 above, the ANOVA comparison of the post-test mean scores of male and female students who were taught with the activinspire software showed that there is no statistically significant difference between the mean scores of male students and female students in the experimental group at 0.05 level of significance ($F_{cal}=0.742$, $df=1$, 58 ; $p>0.05$). This result indicates that there was no significant difference between the mathematics achievement scores of male and female students taught using the activinspire software. Hence, the null hypothesis which states that there is no significant difference between the achievement of male and female students taught mathematics using the active inspire software was not rejected.

CONCLUSION

From the study it is seen that computer aided software active inspire enhanced the performance of the students and had a significant effect on their learning. Students who were taught using the activinspire software were more successful in the achievement test than their counterparts who were taught with the lecture method. Hence, teaching of students using computer aided software would enhance their understanding of concepts taught and thereby improve their academic performance.

There was no obvious difference between the performance of male and female students taught mathematics using the activinspire software. This implies that the use of computer aided software would bridge the gap in between the male and students grasp of concepts taught. Further or similar research could be undertaken on the use of computer aided software to teach more topics in the mathematics syllabus and in more schools across the state and even across the country so as to provide a sound base for the integration of computer aided instruction in schools across Nigeria

RECOMMENDATIONS

The government and educational authorities should look into how the use of the computer could be incorporated into the teaching and learning of mathematics in the following ways:

- i. Every school's mathematics program should provide students and teachers with access to tools of instructional technology, including appropriate calculators, computers with mathematical software, Internet connectivity, handheld data-collection devices, and sensing
- ii. Pre-service and in-service teachers of mathematics at all levels should be provided with appropriate professional development in the use of instructional technology, the development of mathematics lessons that take advantage of technology-rich environments, and the integration of technology into day-to-day instruction.
- iii. Curricula and courses of study at all levels should incorporate appropriate instructional technology in objectives, lessons, and assessment of learning outcomes.
- iv. Programs of pre-service teacher preparation and in-service professional development should strive to instill dispositions of openness to experimentation with ever-evolving technological tools and their pervasive impact on mathematics education.

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