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Effect of Triangle Solver Game on Secondary School Students' Achievement and Retention in Trigonometry in Ogoja Education Zone in Cross River State

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ABSTRACT: The study investigated the effect of triangle solver game on secondary school students' academic achievement and retention in trigonometry in Ogoja Education Zone. Four research questions guided the study, and four null hypotheses were tested at 0.05 level of significance. The design of the study was quasi-experimental design. The specific design was the pretest-posttest. Non-equivalent control group design. The study was carried out among secondary schools in Ogoja Education Zone of Cross River State. The population for the study consisted of 1,945 mathematics students in the Senior Secondary two (SSS 2) in the study area. The sample size 389 drawn from Ogoja Local Government Area. The instrument for data collection was Trigonometry Achievement Test (TAT). TAT was face validated by three experts in the Department of Curriculum and Instructional Technology in University of Cross River State. The reliability co-efficient of the instrument was determined to be 0.98 Using Kuder-Richardson formula (k – R 20). The subjects were pretested before the treated and the posttest was administered after the treatment, while the achievement test was administered two weeks after the end of the treatments. The data collected were analyzed using mean and standard deviation and Analysis of Covariance (ANCOVA). The findings of the study showed that students who were instructed and taught using Trigonometry with triangle solver game achieved higher and retained more than those taught with conventional method. It was also discovered that no particular gender was favored more by the treatment. Based on the findings of the study. It was recommended that secondary school mathematics teachers should be given training on Triangle solver game so that they can use it while teaching. Also, workshops and seminars should be organize for serving teachers so as to acquaint them with the skill of triangle solver game.

INTRODUCTION

Mathematics is defined as a science of numbers, quantities, shapes and spaces. (Chukwu, 2010). Mathematics could be defined as the science of dealing with quantity, forms, measurement and arrangement, in particular with methods of discovering by concepts and symbols the properties and inter-relationship of quantities and magnitude. (Ezekule and Ihezue, 2006).

Mathematics is a physical science that is practically and activity oriented which used abstract symbols, axioms and facts to deal with numbers, shapes and equally solve day to day problems. It is a diversification of different but related topics including number and numeration, basic operation, algebraic process, geometry and mensuration and everyday statistics.

Mathematics has generally been accepted as the foundation of science and technology and it is a very important subject in curriculum (Udousoro, 2011). Unodiaku (2012), opined mathematics is indispensable tool for achieving success in scientific and technological development of any nation. Mathematics is a key to positive and cognitive development, successful daily living, scientific development, lifelong learning etc. ideally, without mathematics, there is no technology and without technology there will not be all the factors of modern society (Ukeje, 1997 in Idigo, 2014).

It is eident therefore that the usefulness of mathematics in every facet of human life is so expedient that there is no school curriculum or national development planning without taking cognizance of development in school mathematics especially in secondary schools. Probably because of this vital support of the national scientific developments which mathematics endeared itself to, the Nigerian government made the study of the subject (Mathematics) compulsory at all levels of primary and secondary schools systems of education in Nigeria as contained in the National policy on education (Federal Republic of Nigeria, 2013).

Effect of Triangle Solver Game on Secondary School Students' Achievement and Retention in Trigonometry in Ogoja Education Zone in Cross River State

Despite the importance of Mathematics as a tool for societal and national developments, its study according to Unochaku (2011) in Nigerian secondary schools in bedeviled by incessant poor achievement among the students. In facts the problems of teaching and learning of mathematics in secondary schools have continued to be tropical and worrisome to mathematics teacher's researcher, parents and examiners. The persistent low achievement in mathematics among secondary school student is a clear manifestation of this perceived problem (West African Examination Council), Chief Examiner's Report, 2009; Usman and Nwoye, 2010; Bot, 2011; Imoke & Anyagh, ,2012; Idigo, 2010).

According to Akinoso (2011), the poor achievement in Mathematics has been associated with teachers' failure to use appropriate teaching strategies. Moreso, what students are taught and how well they comprehend is greatly influenced by the teaching methods used (Okwu and Karume, 2010 in Idigo, 2014; Usman and Nwoye, 2010).

Ogbu (2006), computer based mathematical game is one of the innovations that are in tune with the recent scientific and technological depensation. Game is a structured type of play, usually undertaken for entertainment or fun, and sometimes seen as an educational tool (Wikipedia). A game is an enjoyable and organized competitive activity involving physical effort and skill that is guided by races.

A computer game is an interactive entertainment running on computers, game consoles or electronic devices, such as mobile phones and Personal Digital Assistants (PDAs). Computer game is a computer-based activity which leads participant to keep joyfully (Ozofor, 2001). In the last few years a tool for facilitating earning in different sectors of society. Soe of the computer-based mathematical instructional games include Darts-pluto project, Harpoon, lemonade stand, mathematics blaster, Millies Math House, Triangle soler (Drill and practice game) cashier games, treasure hunt etc. (Mansureh, 2008).

However, as interesting as computerized mathematical games may sound, science educators still vary in their opinions as regards it use for teaching mathematics. A number of science educators believe that computer programs have tremendous potential for the enhancement of teaching and learning of science concepts. Other maintain that animations and computer software are used to facilitate the visualization of abstract concepts and processes at the micro-level of instruction. (Tsui & Treagust, 2007). Yet some researchers and some educators caution that the use of computer aided instruction can exacerbate problem/result to bad situation in teaching and learning. They reported that computer aided instruction can hinder deep reflection and understanding of complex science content (Marshal & Young, 2006, Waight & Abd-Khalick, 2007). All this gaps were bridged by this study. This work was based on a computer game (Drill and practice game) aided by Trigonometry tutorial).

Triangle solver-trigonometry game is designed to promote learners' techniques for solving trigonometry equations. Triangle solver is a Microsoft mathematics educational program designed for Microsoft windows that allow users to solve mathematics, science and technically related problems, as we as to educate the users. Triangle solver trigonometry game is primarily targeted at students as a learning tool. It is a computer aided instruction package, and it is user friendly.

Purpose of the study

The purpose of the study was to investigate the effect of triangle solver game on secondary school students' academic achievement and retention in trigonometry in Ogoja Education Zone of Cross River State.

Research questions

The following research questions guided the study:

1. What is the mean and standard deviation achievement scores of students in the experimental and control group?
2. what is the mean and standard deviation achievement scores of male and female student in experimental and control group?
3. What is the mean and standard deviation retention scores of male and female students in experimental and control group?

Hypotheses

The following research hypotheses were tested at 0.05 level of significance.

Ho1: There is no significant difference between the mean and standard deviation achievement scores of students in experimental and control groups.

Ho2: There is no significant difference between the mean and standard deviation retention scores of students in experimental and control groups.

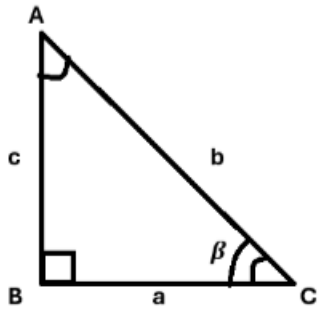
Ho3: There is no significant difference between the mean and standard deviation achievement scores of male and female students in experimental and control groups.

Ho2: There is no significant difference between the mean and standard deviation retention scores of male and female students in experimental and control groups.

METHODOLOGY

This study adopted a quasi-experimental resign design specifically pretest posttest non-equivalent control design was used. Nworgu (2015) defined quasi-experimental research design was one which random assignment of subjects to experiment and control groups is not possible. The choice of the designs according to Nworgu (2007) is because the was no randomization of research subject not groups. This was to avoid disorganization of the school arrangement. These intact classes were used for the study. However, the intact classes were randomly assigned to either experimental or control groups. According to Nworgu in Okoro (2015), an essential ad indispensable feature of quasi-experimental design is the use of control group. He opined that a control group is one to which experimental treatment was not administered. A control group therefore usually provides the baseline against which to compare the effect of the experimental treatment on the experimental group. Expository method was used on the control group because it is traditional method used in all schools.

The teachings was for six (6) weeks. Each week had one contact period of 40 minutes durations. At the start of the experiment, all the students in the experimental groups where exposed to instructional technology. During subsequent meeting with the students, the teach also used instructional technologies to teach them and each student as given a copy of the question stem and the teacher encourages the students to write down questions relating to what they have been previously taught. For example, the topic is Trigonometrical ratio. Thus, the use of instructional technology triangle solver game can be used to teach.



a = Adjacent side
b = Hypotenuse side
c = Opposite side

If the angle is at A then, the side of the triangle will be named as follows;
a = Opposite
b = Hypothenuse side
c = Adjacent side

Therefore, with reference to the above triangle the side a is the adjacent side with reference to angel c, the side b is the hypothenuse side with reference to angle c and the side c is the opposite side with reference to angle c.

Throughout, the lesson for the experimental group questions were posed by the teacher at appropriate times after sufficient content had been taught for the students to consider. alter the students also tried to answer the questions by themselves. The students tried to solve some questions using instructional technology (triangle solver game) which were used in the class to teach them. The practice was repeatedly carried out weekly in the class using same instructional technology devices in mathematics is expected to help students' gain the sense of mastery in the learning. The students in the control group did not receive ay instruction with instructional technology devices (triangle solver game). At the end of four weeks, all the students was be tested on achievement test will be given two weeks after termination of the treatment. The materials of teaching the students were the questions. The experimental group students were told the use of instructional technology (triangle solver game) and asking questions in the way of managing and how to check their achievement and monitoring their learning will make their performance better in mathematics. The practice question was adopted from some questions in TONAD ESSENTIAL MATHEMATICS for Secondary School Two (SSS 2) and WAEC questions and modified by the researchers were distributed to all the student the experimental group at the start of their lesson by using instructional technology device. The teacher lead the students on how to solve the questions by using the instructional technology device (triangle solver) to solve specific content elated questions using some of

the questions several times throughout the lesson each week. The teacher lead the students to solve trigonometry questions using different sets of instructional technology and write out the solution and answer as it is suppose to be (well). At the starting of each weeks' lesson, students practice and discuss their answers with member of their small group. The instrument for data collection was Trigonometry Achievement Test (TAT). The TAT was adopted from the West African Examination Council (WAEC) past questions papers and the item covered the content (trigonometric ratio to be taught on the period of task to covered TAT was initially made up of 50 multiple choice questions with four options each (A, B, C and D). the instrument was divided into two sections, section "A" of the achievement test personal…..

Information from the students while section "B" was based on the questions on trigonometry. The TAT was administered as the pretest and the items were rearranged and then re-administered to the students as posttest after the treatment. The achievement test in trigonometry with a masking scheme, were given to three experts for face and content validation. Two of the experts were from mathematics education and one of the experts was in measurement and evaluation.

The reliability of the instrument (TAT) was established through a pilot study on 45 SS 2 students of Saint Thomas College, Ogoja. The researcher computed the internal consistency of the instrument TAT using Kudar-Richardson formula (20). The choice of using K-R (20) is influence by the fact that it is best used on multiple answer (Peters, 2016). The reliability coefficient obtained for TAT is 0.98.

Experimental procedure

The treatment was carried out in the school's classroom at the normal mathematics period. The treatment and testing were done by their regular class teachers. The pretest was administered before the experimental treatment. The posttest was given immediately after the treatment. The researcher organized one week training programme for the teachers that trained the students at about one week before the starting of the actual teaching of the students. The teachers were involved in the study, that is in both experimental and control groups. Teachers were told to teach the same trigonometry ratio during the period.

STATEMENT OF THE PROBLEM

The persistent poor achievement students in mathematics as revealed by both research evidence and WAEC chef examiners' report calls for great concern. This poor acheievemtn has bee traced partly to many factors including poor teahing methods. Presently, there are lots of cries to improve o the method of teaching mathematics in order to enhance this poor menaces.

It should be noted that educators and researchers have recommended the use of effective teaching method which is in tune with modern scientific and technological dispensation as a remedy to the poor marrance in secondary schools mathematics. Such recommended teaching methods include Constructivist Approach Teaching Strategy Peer Assisted Learning Strategies, Computer Aided Instruction, Computer Animation Instructional Strategy, Discovery Method, Computer game, simulation game, Delay formalization Approach etc. Computer game such as triangle solver, trigonometry game is in tune with the most recent scientific and technological developments. This game perfectly combines amusements, pleasure and challenges in facilitating mathematical thinking.

The questions are how did computer-based mathematics a game affect students academic achievement and retention in secondary school trigonometry? Which of the gender benefit more than the other in achievement and retention in compute-based game methods?

Research question 1: What are the mean and standard deviation trigonometry achievement scores of students in experimental and control groups in pretest and posttest?

Table 1: Mean and standard deviation trigonometry achievement scores of experimental and control group in pretest and posttest

Group	N	Pretest Mean ()	SD	Posttest Mean ()	SD
Experimental group	185	33.13	13.32	63.53	9.37
Control group	204	25.05	13.10	47.33	9.72

In Table 1, the pretest mean and standard deviation trigonometry achievement sores of the experimental group were 33.13 and 13.32 respectively and their posttest scores were 63.53 and 9.37 respectively. For the control group, the pretest mean and standard deviation trigonometry achievement scores were 25.05 and 13.10 respectively, while the post test were 47.33 and 9.72 for the mean and standard deviation achievement scores respectively.

There was not much difference between the two groups in the pretest but there was appreciable differences in the posttest. The experimental groups scores of both groups in pretest, posttest did not differ significantly.

Research question 2: What is the mean and standard deviation trigonometry scores of students' in experiment and control groups?

Table 2: Mean and standard deviation trigonometry retention scores of students in experimental and control groups

Group	N	Retention Mean ()	SD
Experimental group	185	61.85	9.10
Control group	204	46.90	11.81

The mean and standard deviation trigonometry scores of students in experimental group were 61.85 and 9.10 respectively, while those of the control group were 46.90 and 11.81 for the mean and standard deviation respectively. this result indicates that the experimental group retained more than the control group.

Research question 3: What are the mean and standard deviation trigonometry achievement scores of male and female students in experimental and control groups in pretest and posttest?

Table 3: Mean and standard deviation trigonometry scores of male and female students in experimental and control groups pretest and posttest

Group	N	Pretest Mean ()	SD	Posttest Mean ()	SD
Experimental male	92	34.63	12.72	62.45	9.43
Experimental female	99	25.64	14.18	48.83	10,04
Control male	93	31.70	13.95	64.55	9.21
Control female	105	26.02	12.04	46.05	9.57

Table 3 above shows that male students in the experimental group had a mean score 34.63 and 62.45 and standard deviation scores of 12.72 and 9.43 in pretest and posttest respectively while male in the control group had mean scores of 25.64 and 48.83 and standard deviation scores o 14.18 scores pf both groups ass more significant in the posttest with males in the experimental group far above those in the control group.

The female in experimental group had mean scores of 31.70 and 64.55 and standard deviation scores of 13.95 and 9.21 in the pretest and posttest respectively as against mean scores of 26.02 and 46.05 and standard deviation of 12.04 and 9.57 of control group showing that the experimental group achieved higher.

Research question 4: What are the mean and standard deviation trigonometry retention scores of male and female students in experimental control groups?

Table 4: Mean and standard deviation trigonometry retention scores of male and female students in experimental and control groups

Group	N	Retention Mean ()	SD
Experimental male	92	65.30	7.25
Experimental female	93	65.91	7.33
Control male	99	47.96	9.94
Control female	105	48.07	9.04

The mean and standard deviation retention scores for male students in experimental group was 7.25 for standard deviation, while it was 65.91 and 7.33 for female in experimental group. Also, male in control group had a retention mean score of 47.96 and standard deviation while female in control group had 48.07 and 9.04. This result showed that the groups did not differ in their mean retention scores-based o their gender.

HYPOTHESIS 1

There is no significant difference between the mean trigonometry achievement scores of students in experimental and control groups.

HYPOTHESIS 3

There is no significant difference between the mean trigonometry achievement scores of male and female student sin the experimental and control groups.

HYPOTHESIS 5

There is no significant interaction between teaching method and gender on students' achievement scores in trigonometry.

HYPOTHESES 1, 3, AND 5

There is no significant difference between the mean trigonometry achievement scores of student sin experimental and control groups.

Table 8: **ANCOVA results of the students' achievement scores**

Source	Sum of square	DF	Mean square	F	Sig.	Decision
Corrected model	17.996	3	5.999	1.684	0.011	
Intercept	72011.611	1	72011.611	2311.4	0.19	
Gender	6.065	1	6.065	.035	.853	NS
Method	9053.854	1	9053.854	51.518	.000	S
Gender method	217.286	1	217.286	1.236	.268	NS
Error	26468.1725	385	68.7485	3.161		
Total	516323.000	389	1327.3085			
Corrected total	11474.333	387				

Gender as main effect gave an f-value of .035 and this is significant at .853. Since .853 is greater than .05, this means that at.05, the f-value of .035 is not significant. Therefore hypothesis 2 is not rejected as stated, indicating that there is no significant difference between the achievement of male and female students. In addition, the sum of squares arising from gender (6.065) is highly insignificant in comparison with the sum of squares arising from error (26468.1725). this indicates that any observed difference is as a result of extraneous variable, hence the insignificant of the difference in the mean scores.

Method (Experimental and control) as main effect gave an f-value of 51.518 and this significant at .000. Since .000 is less than 0.5, this means that at .05 level, the f-value of 51.518 is Significant. Therefore, hypotheses 1 is rejected as stated, indicating that there is significant difference between the mean achievement scores of the experimental and control groups. Also, the sum of squares arising from method (9053.854) is highly significant in comparison with the sum of squares arising the error (26468.1725). this indicates that the observed difference in the achievements of the experimental and control groups is due to the treatment administered in the experiment.

The interaction effect (Gender/method) gave an f-value of 3.161 which is significantly at .258. Since .268 is greater than .05, this means that at .05 level, the f-value of 3.161 is not significant. Therefore, hypothesis 5 is not rejected as stated, indicating that there is no significant effect between method and gender on students' achievement in trigonometry in this study. The sum of squares arising from gender/method (217.286) is highly insignificant in comparison with the sum of squares arising from error (26468.1725) indicating that any observed difference may be due to extraneous variables.

HYPOTHESIS 2

There is no significant difference between the mean trigonometry retention scores of students in the experimental and control groups.

HYPOTHESIS 4

There is no significant difference between the mean trigonometry retention sores of male and female students in the experimental and control groups.

HYPOTHESIS 6

There is no significant interaction between teaching method and gender on students' retention scores in trigonometry

Table 9: **ANCOVA results of the students' retention scores**

Source	Sum of square	DF	Mean square	F	Sig.	Decision
Corrected model	2268.425	3	756.1417	.002	.967	
Intercept	61234.101	1	61234.101	4.211	.807	
Gender	8.324	1	8.324	.075	.785	NS
Method	7451.213	1	7451.213	67.128	.000	S
Gender method	142.908	1	142.908	3.291	.258	NS
Error	16717.47	385	43.422			
Total	494336.000	389	1270.7866			
Corrected total	8299.785	387				

In the table above, gender as main effect gave f-value of .075 which is significant at .0785 but insignificant at .05 since .785 is greater than.05. Hence, hypothesis 4 is not rejected as stated indicating that there is no significant difference between the mean retention scores of male and female students in the study. The sum of squares arising from gender (8.324) is highly significant in comparison showing the sum of squares arising from error (16717.47) showing that any observed difference is due to extraneous variable.

Method (experimental and control) as main effect gave an f-value of 67.128 which is significant at .000. Since .000 is less than .05, this means that the f-value of 67.128 is significant. Therefore hypothesis 2 is rejected as stated indicating that there is a significant difference between the mean retention scores of the experimental and control groups. The sum of squares arising from method (7451.213) is highly significant when compared with the sum of squares arising from error (16717.47) showing that the observed difference was due to the treatment administered.

The interaction effect between gender and method an f-value of 3.291 which is significant at .258. Since .258 is greater than .05, this means that at .05 level, the f-value of 3.291 is not significant. Therefore, hypothesis 6 is not rejected as stated indicating that there is no significant interaction effect between the male and female students' retention in trigonometry. The sum of squares arising from gender/method (142.908) is highly insignificant in comparison with (16717.47) arising from error, indicating that any observed difference in this regard is due to extraneous variable.

Summary of Findings

The results presented above can be summarized thus;

The students' taught trigonometry with triangle solver game achieved higher than those taught with conventional method.

The students taught trigonometry with triangle solver game retained more than those taught with conventional method.

Male and female students taught trigonometry with triangle solver game achieved in equal proportion.

Male and female students taught trigonometry wit triangle solver game retained in equal proportion.

There was no significant interaction between teaching method and gender on the students achievement and retention in trigonometry.

DISCUSSION OF THE FINDINGS

Discussion of the findings was made under the following sub-headings; students' academic achievement in trigonometry, students' academic retention in trigonometry and interaction between teaching method and gender on students academic achievement and retention in trigonometry.

Students' academic achievement in trigonometry results presented in table 4 showed that there was not much difference between the two groups in the retest. However, after treatment the experimental group achieved higher with an appreciable difference in the standard deviation.

Table 6 revealed that male and female students in both groups had close mean and standard deviation scores in pretest and posttest, apparently showing that they achieved equally. Tables further revealed that there was no significant interaction between teaching methods and gender on the student academic achievement in trigonometry.

With evident, these results implicated method of teaching as a major factor affecting students academic achievement in trigonometry. The finding supports the recommendations of the WAEC chief examiners' report (2020) for the use of effective

teaching method which is in tune with modern scientific and technological dispensation as a remedy to students' poor academic achievement in Senior Secondary School Examination Mathematics. This was also in support of the findings of Randy and Trunelle (2008) who supported the usefulness of AI in teaching and learning.

Students' academic retention in trigonometry

Table 5 showed the students taught with computer game (triangle solver game) retained more than those taught with conventional method. The findings of this study is in line with the findings of Eze and Egbo (2007) whose reports revealed that students taught through computer-aided practice retained more than those taught with the traditional lecturer method.

Table 7 showed that male and female students taught trigonometry with computer games retained higher. The findings of this study is in line with Hydea and Mertzb (2009) whose reports revealed that female have reached partly with male. However, the findings is not in line with the findings of Ogunkunle (2007) whose report revealed significant difference in favour of make a in another part in favor of female. Tale 9 showed that there was no significant interaction between teaching method and gender on the students' academic retention in trigonometry.

Interaction between teaching method and gender on students' academic achievement and retention in trigonometry. Table 8 and 9 showed that there is no significant interaction between teaching method and gender on students' academic achievement and retention.

This result agrees with the findings of Abiam and Odok (2006) that there is no significant interaction between teaching method and gender on students' academic achievement in mathematics. This result affirms the findings of Ozomadu (2006) who revealed no significant interaction between teaching method and gender on students' academic retention in mathematics.

CONCLUSION

Based on the findings of this study, the following conclusions were made;

Triangle solver game elicited higher achievement than conventional method.

Triangle solver game promoted higher retention than conventional method.

Interaction effect between teaching methods and gender was insignificant.

RECOMMENDATIONS

Consequent upon the findings of the study, the following recommendations are made;

Computer game and other computer-aided instructions should be used in teaching mathematics in secondary schools.

Mathematics and science teacher should be trained through seminars and workshops should be organized to train in-service teachers on the use of computer instruction for teaching and learning of sciences generally and mathematics in particular.

Personal laptops and computer should be given to secondary school mathematics teachers by the government.

Government should established mathematics laboratories in secondary schools and equipped the laboratories with computers for effective teaching and learning of mathematics.

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