

Effect of Mathematics Game-based Instructional Techniques on Students' Achievements and Interest in Algebra at Basic Education Level

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Abstract

The study investigated the effect of game-based instructional technique on achievement and interest of students in Algebra at the basic educational level. A quasi-experimental, non-equivalent control group design used in carrying out the research; the researcher used all the JSS II students in Obio-Akpor local Government Area of Rivers State as the population of the study. One hundred and thirty-four students from four schools (male and female) sampled, were used as sample for the study. Intact classes were assigned by hat and draw to either experimental or control group: and separately taught by their regular mathematics teachers who had earlier been trained for the purpose. All the groups were pre and post tested. Algebra Achievement Test (AAT) containing twenty multiple choice test and an Algebra Interest Inventory containing twenty items were used as instruments for both the control and the experimental groups. Four research questions and six hypotheses guided the study. The mean and standard deviation were used in answering the research questions while Analysis of Covariance (ANCOVA) was used in testing

the hypotheses at $p < 0.05$ level of significance. The result showed that the use of Game-based instructional technique in teaching affects students' achievement and interest in Algebra. Also there was no significant interaction effect between the teaching method and gender on students' achievement and interest in Algebra. The study recommended above among other things the incorporation of Game – Based teaching in mathematics classes and textbooks, organization of workshops and seminars for teachers and others concerned on the use of Games in teaching and learning of mathematics especially in Algebra.

AMS subject classification:

Keywords: Achievement, Algebra, Game-Based Instruction, Instruction, Mathematics.

1. Introduction

Mathematics occupies a central place in the Nigerian educational system. According to Maduabum and Odili (2006), mathematics is a science of quantity and space and occupies a key position in Nigeria's education system. Mathematics can also be seen as a human invention, born out of human search to solve human problems (Kolawole and Oluwatayo, 2005). Mathematics has many branches like set, logarithm, trigonometry, geometry, statistics, vector and algebra. According to Brian (2010), algebra is the branch of mathematics which is concern with structure, relation and quantity. Studying mathematics as well as algebraic concepts, variables processes and equations have many advantages.

Mathematics without doubt remains very important to all disciplines and fields of human work and study (Odili, 2006). It has continued to play significant role in the development of both the individuals and nations. Mathematics is a necessary tool needed to be able to function effectively in the present technological age (Aremu, 1998). Even the ordinary man in the street will agree to this fact that mathematics is of great importance to man existence. According to Abakpa and Iji (2011), Mathematics is an intellectually stimulating subject that affects every talent of human activities such as politics, economics science and technology. The importance of mathematics to nation building cannot be over emphasized; this led the Federal Government of Nigeria to make mathematics a core subject to be offered by students at some levels of education in Nigeria in that mathematics education is the bedrock of scientific and technological development in any country (Federal Republic of Nigeria, 2004). Okafor (2002) also noted that mathematics is a compulsory entry requirement into some courses in university education. One is expected to credit mathematics to qualify one to study at the higher education level. However, despite the significance of mathematics to man and the enviable position it occupies in the community of disciplines, students' achievements in the public examination have continued to exacerbate year by year.

The achievement of students in Nigerian secondary schools appears to be poor and this has been causing a lot of concern. Students perform poorly in both internal and

external examinations (Ale & Adetula, 2005). For instance, in 1996 over, 52.9% of Nigerian students failed Mathematics in Senior Secondary School Examination. Also in the years 2008, 2009, 2010 and 2011 the percentage of pass at credit and above were 23.0%, 31.0%, 24.94% and 38.98% respectively (Kurumeh & Imoko 2008; Iyi, 2011; WAEC, 2006-2011, 2010, 2005-2009). Adeleke (2007) observed that one particular area of mathematics which students' problem dominant is algebra. In the same line, Martin (2000) observed that algebra is also one of the branches of mathematics that many secondary school students find difficult to understand. Perhaps this is so because historically, algebra has represented students' first sustained exposure to the abstraction and symbolism that makes mathematics powerful. According to Kurummeh and Achor (2008), several variables are responsible for the poor performance of students in mathematics and these includes methods to which the content is being presented to the students, lack of interest among the students and abstractness of mathematical concepts among others.

Interest is an important variable in learning because when one is interested in an activity, one is likely to perform positively. Interest is a subjective feeling of concentration or persisting tendency to pay attention and enjoy some activity or content (Imoko & Agwagah, 2006). Though some children may be intellectually and physically capable of learning, they may never learn until their interest is stimulated. Once the students are stimulated, they will continue to learn as long as the teacher is capable of sustaining their interest in the subject matter. This is because interest brings about attention, once there is direct interest, attention is guaranteed and learning is assured. Also, interest can be expressed through simple statements made by individuals of their likes and dislikes and one is likely to do well in a discipline of interest. The low interest in mathematics emanates from anxiety and fear. Phobia has been observed by Aprebo in Okigbo (2010) to be an academic sickness whose virus has not yet been fully diagnosed for an effective treatment in the class and the symptoms of this phobia are usually expressed on the faces of mathematics students in their classes. The WAEC Chief Examiner's Report (WAEC, 2005–2009) suggested that teachers should help students improve their achievement and develop interest in mathematics by reducing the abstractness of mathematics, and remove their apathy and fears of the subject. In the same vein the gender difference in interest and achievement of students in mathematics has been a thing of worry to mathematics educators and researchers.

Gender is the stratification and assignment of roles along sex line which may be culturally determined, which is ascribed to male and female (Udaya, 2010). Gender disparity in mathematics performance is one that cannot be swept under the carpet. Modern psychology studies have shown that gender as a variable relates to performance (Ezeugo & Agwagah, 2000). Although most researchers have found boys performing better than girls (e.g. Adeleke, 2008) especially on higher order knowledge, a few others saw girls out-performing boys while some others established no significant difference particularly during early education. In light of the above, if any method is suspected to increase performance and interest in mathematics, its effect on gender should be put into consideration.

Nigeria as a developing country needs innovation in teaching and learning process. Unfortunately, the teaching and learning of Mathematics at all levels of the educational system in Nigeria can be described to be in a dismal state (Amazigo, 2000). Many variables have been implicated as responsible for the low performance of students. Amazigo (2000) identified specific variables, such as poor primary school background in mathematics, lack of interest on the part of students, incompetent teachers in the schools, large classes, fear of the subject psychologically among others. Supporting the above, Ale and Adetula (2005) reported that research reports have offered several reasons for the students' poor performance in mathematics. The reasons include; Lack of qualified mathematics teachers, Student's lack of interest and as well as negative attitude towards mathematics, Teachers own negative attitude and incompetence in certain mathematics concepts and Poor methods of the teaching applied by the teacher in the classroom. Agwagah (2001) was of the opinion that teachers' non-use of relevant instructional materials in the teaching of mathematics concepts also contribute to the poor performance of students in the subject. The National Mathematical Centre, in an attempt to revamp Mathematics teaching and learning at Secondary Schools, has successfully researched into the causes and remedies for the abysmal failure in WAEC, SSCE and JAMB Mathematics examinations. The body discovered that poor performance in the public examinations in Mathematics has more to do with the teachers' method of teaching than the nature of the content of curricular of the school Mathematics (National Mathematical Centre, 2009). This may be because the most science teachers' method of teaching is characterized by the conventional method of teaching which involves one directional flow of information from the teacher to the students Iloputaife, (1996).

The above necessitated and spurred the Center's Mathematics Improvement Programme (MIP) project to introduce a new teaching methodology to enhance students' performance in Mathematics. The game-based instructional technique is one of the new methods that are being used in the teaching and learning process. Games have been defined by many authors in various ways. According to Ayotola (2003), game is explained as a contest in which people agree to abide by a set of rules in an attempt to win an objective. Games are social activities with sets of rules in which the hallmark is to win (Ezeamaenyi & Alio, 2004). Games can be defined in this study as interactive activity by which the participants contest based on accepted rules. The value of games in teaching and learning cannot be over emphasized. That is why Ayotola, (2003) and Eze, (2006) stressed that games motivate, develop skills, abilities and strategies. Hence the Algebraic Substitution Attack Game, Algebra Snadder Joint Game and Number Line Game were adapted in this study.

From the above discussed, it is clear that the performance and interest of students in mathematics is highly dependent upon the teaching and learning method (Nakpodia, 2006). Studies have also revealed that games can be used in the teaching and learning process. Despite all these significant result recorded in other areas of mathematics and other subjects, it becomes obvious that none has been done on the effect of games based instructional technique on algebra at the basic educational level. To these end, the present study sought to find out if the use of game based instructional technique will enhance

secondary school achievements and interest in algebra at the basic educational level.

2. Research Questions

The following research questions guided this study.

1. What is the mean achievement scores of students taught algebra using the game-based (Algebraic Substitution Attack Game, Algebra Snadder Joint Game and Number Line Game) instructional technique and those taught with conventional approach
2. What are the mean achievement scores of male and female students taught algebra using the game-based (Algebraic Substitution Attack Game, Algebra Snadder Joint Game and Number Line Game) instructional technique.
3. What is the mean interest scores of students taught algebra using game-based (Algebraic Substitution Attack Game, Algebra Snadder Joint Game and Number Line Game) instructional technique and those taught with conventional approach?
4. What are the mean interest scores of male and female students taught using game-based (Algebraic Substitution Attack Game, Algebra Snadder Joint Game and Number Line Game) instructional technique?

3. Hypothesis

The following hypothesis were formed to guide the study and were tested at 0.05 level of significance.

- HO₁: There is no significant difference among the mean achievement scores of students taught Algebra (mathematics) using game-based (Algebraic Substitution Attack Game, Algebra Snadder Joint Game and Number Line Game) instructional technique and those taught without the method, as measured by the Algebra Achievement Test (AAT)
- HO₂: There is no significant difference between mean achievement scores of male and female students taught Algebra (mathematics) using game-based (Algebraic Substitution Attack Game, Algebra Snadder Joint Game and Number Line Game) instructional technique, as measured by the Algebra Achievement Test (AAT)
- HO₃: There is no significant difference in the mean interest scores of the students exposed to the game-based (Algebraic Substitution Attack Game, Algebra Snadder Joint Game and Number Line Game) instructional – technique and control group, as measured by the Algebra Interest Inventory (AII)

HO₄: There is no significant difference in mean interest scores of male and female students exposed to the game-based (Algebraic Substitution Attack Game, Algebra Snadder Joint Game and Number Line Game) instructional–technique, as measured by the Algebra Interest Inventory (AII)

HO₅: There is no interaction effect of gender and method on achievement of students as measured by the Algebra Achievement Test (AAT)

HO₆: There is no significant interaction effect between method and gender on students' interest in algebra, as measured by the Student Algebra Interest Inventory (AII).

4. Methods

The Design of the Study

This study adopted a nonequivalent-control group (pre-test and post-test) quasi experimental design. The reason for the adoption of this design is hinged on the fact that intact classes was randomly assigned to experimental and control groups respectively, since it was not possible to have complete randomization of subjects (Nworgu, 2015).

The Area of Study

The area of this study was Obio-Akpor Local government Area of Rivers State in Nigeria. Obio-Akpor local government area is one of the 23 local government areas of Rivers State of Nigeria. Each local government has a sole control over the schools in their local government.

Population of the study

The population of this study consists of all the 2014/2015 academic year Junior Secondary School two (JSS 2) students of government owned secondary schools in Obio-Akpor Local government Area of Rivers State in Nigeria. There are 22 junior Secondary schools in the Local Government Area. These 22 schools are made up of 15 co-educational schools and 7 single-sex schools of 4 boys' schools and 3 girls' schools.

Sample and Sampling Techniques

The sample consists of 134 students which are composed of 69 male and 65 female students. Purposive sampling will be used to select four government single-sex educational schools for the study, two boys' school and two girls' school the reason being that the schools must satisfy the basic conditions that will aid effective use of games for instruction. Each of the boys' school and the girls' school was assigned randomly to experimental and control group using the "hat and draw" method that is using the lucky dip. Simple random sampling used to select one intact class from each of the four schools. The experimental and control group was made of one boys' school and one girls' school, having a total of 67 students in each group.

Instrument for Data Collection

The instruments that were used to collect data for this study were the Algebra Achievement Test (AAT) and Algebra Interest Inventory (AII). AAT is the researcher – made instrument that consisted of 20 items prepared based on JSS 2 mathematics curriculum in Algebra. The items of AAT were developed using lower and higher order questions. The lower order questions covered knowledge and comprehension of the cognitive domain while questions involving higher thinking processes covered application. The 20 items were multiple-choice objective questions with four options (A, B, C, and D). AAT was scored out of 100% meaning each item correctly answered is 5 marks. The AII is the researchers’-made 20 items questionnaire that was used to help students express their feelings towards mathematics generally and algebra in particular. It consists of two sections. Section A sought general information about respondents, while section B bothered on their interest in Mathematics. Each of the items is a 4-point Likert – type-rating scale with 4 response options. The options are: Strongly agree (SA), Agree (A), Disagree (D), Strongly disagree (SD) rated 4, 3, 2 and 1 for all positive statements and 1, 2, 3 and 4 in that order for all negative statements.

Validation of the Instruments

Both instruments were validated by experts in mathematics education and measurement and evaluation of university of Nigeria Nsukka and Alvan Iko Federal College of Education Owerri. For the face validation, the validates went through the purpose of study, research questions, and test blueprint which helped them in accessing the suitability of the items of the instruments, checking the ambiguity of the statements, making sure that the items addresses all it suppose to and making suggestions towards the improvement of the instrument. For the content validation, the table of specification was used. This specifies the distribution of the AAT items under low ability and high ability. The samples of the lesson note were made available too to make sure that it is relevant to the JSS 2 algebra topics. After the validations, and necessary corrections made based on the valuator's comments, suggestions and criticisms, 20 items emerged from the AAT while 20 items emerged from the IIT.

Reliability of the Instruments

The Kuder-Richardson (KR-20) was used to estimate the internal consistency (reliability) of the instrument AAT. Internal consistency of the item in the instrument using K-R20 formula was adopted because the responds of the items was dichotomously scored. The choice of option from A B C D tells if you are right or wrong. The Cronbach Alpha (α) was used to estimate the internal consistency (reliability) of the AII. The choice of Cronbach Alpha (α) method is based on the fact that the responses of the items in the instrument were not dichotomously scored. In other words, the responses does not entail right or wrong, pass or fail answers but the level of agreement or disagreement with each statement of the given items in the instrument. In summary, the reliability test on AAT yielded co-efficient of internal consistency of 0.7 and 0.8 on AII which indicates that the

reliabilities are very high and could therefore be used for the main study.

Training of Teachers for the Conduct of the Study

The regular mathematics class teachers of the four secondary schools selected for the study was trained to assist in the study. This took a week before the actual study. The training was based on the purpose of the study, the topics to be taught, the use of the lesson plan, the use of the instructional games and general conduct of the study. The teachers were trained to teach both the experimental and control groups. For the experimental groups, the teachers were advised to use game based instructional technique to teach the students why the conventional method was used to teach the control groups.

Experimental Procedure

The experimental groups were taught using game based instructional technique while the control groups were taught the same topic using the conventional method. The games (Algebraic Substitution Attack Game, Algebra Snadder Joint Game, and Number Line Game) were adopted from the resource materials of the National Mathematical Centre, Abuja Nigeria. The pre-AAT and pre-AII was administered before the actual study. The actual teaching was done in the first, second and third weeks while the post-AAT and post-AII was administered in the fourth week. The scores from the post tests were collected and used to provide information on students' achievement and interest across gender and treatment groups.

Lesson Notes

Two lesson notes were prepared in each topic to be used for the study by the researcher, one for the experimental group and the other for the control group. The lesson notes for the experimental group contains the demonstration using algebra mathematics games (Algebraic Substitution Attack Game, Algebra Snadder Joint Game, and Number Line Game).

Control of Extraneous Variables

A number of steps were taken to control some extraneous variables that constitute traits to the validity of the study. These variables include:

1. Teacher variable
2. Inter group variable
3. School variable.

Teacher Variables

The students' regular mathematics teachers were used to carry out the study. The teachers were involved in both the control and the experimental groups while the researcher does the supervision. A uniform standard in the content of the lesson was ensured with the

researcher prepared lesson plans and clearly stated lesson objectives to reduce teacher effect.

Inter Group Contamination

Students in a particular sample school were subjected to the same treatment, either as control or experiment. The case of having both the experimental and control groups in the same school was avoided to eliminate inter group contamination.

School Variable

Schools that were used for the study were schools that provide similar environmental conditions and homogeneous learning background to the subjects.

Method of Data Collection

Before the commencement of the experiment, the researcher administered the pre-tests (AAT and AII) to all the subjects in both groups. The scores were collated for use after experiment. After the experiment, the post-tests (AAT and AII) were administered to all the subjects in both groups. However in these post-tests the items of the AAT and AII were re-arranged/reshuffled to avoid familiarity with the items of the instrument by the students. Data for the pre-tests and post-tests were recorded separately for each of the groups

Method of Data Analysis

The research questions were answered using means(\bar{X}) and standard deviations (S.D). Hypotheses were tested at 0.05 level of significance using two way Analysis of Covariance (ANCOVA). The pre test scores served as the covariates.

5. Results

Research Question 1: What are the mean achievement scores and standard deviation of students taught algebra using the game-based instructional technique and those taught with conventional approach?

From Table 1 above, it can be observed that the experimental group which represents those taught with the game based approach obtained a mean achievement score of 47.91

Table 1: Mean Achievement Score and Standard Deviation of Students Taught Mathematics Using Game Based instructional Technique and the Conventional Approach

Groups	No	Pre test		Post test	
		Mean(\bar{X})	SD	Mean(\bar{X})	SD
Experimental	67	47.91	9.42	76.94	9.98
Control	67	49.62	9.78	48.66	7.95

Table 2: Mean Achievement Score and Standard Deviation of Male and Female Students Taught Mathematics Using Game Based Instructional Technique and the Conventional Approach

Group	No	Pre-test		Post-test	
		Mean(\bar{X})	SD	Mean(\bar{X})	SD
Experimental					
Male	32	46.09	8.40	79.84	9.11
Female	35	49.57	10.10	74.56	10.17
Control					
Male	37	50.67	9.51	48.92	7.37
Female	30	48.33	10.11	48.33	8.74

and a standard deviation of 9.42 in pre test (PREAAT) and a mean achievement score of 76.94 and a standard deviation of 9.98 in post test (POSTAAT). From the table also, it can be observed that the control group which represents those taught with the conventional approach obtained a mean achievement score of 49.62 and a standard deviation of 9.78 in pre test (PREAAT) and a mean achievement score of 48.66 and a standard deviation of 7.95 in post test (POSTAAT).

Research Question 2: What are the mean achievement scores and standard deviation of male and female students taught algebra using the game-based instructional technique?

Table 2 shows that the male students in the experimental group had a mean achievement score of 46.09 and a standard deviation of 8.40 in pre test (PREAAT) and a mean achievement score of 79.84 and a standard deviation of 9.11 in post test (POSTAAT). On the other hand, from the same table, the female students in the experimental group had a mean achievement score of 49.57 and a standard deviation of 10.10 in pre test (PREAAT) and a mean achievement score of 74.56 and a standard deviation of 10.17 in post test (POSTAAT).

For the male and female students in the control group, it could be seen that the male students had a mean achievement score of 50.67 and a standard deviation of 9.51 in pre test (PREAAT) and a mean achievement score of 48.92 and a standard deviation of 7.37 in post test (POSTAAT). On the other hand, from the same table, the female students in the control group had a mean achievement score of 48.33 and a standard deviation of 10.11 in pre test (PREAAT) and a mean achievement score of 48.33 and a standard deviation of 8.74 in post test (POSTAAT).

Research Question 3: What are the mean interest scores and standard deviation of students taught algebra using game-based instructional technique and those taught with conventional approach?

From Table 3, it is observed that the experimental group had a mean interest score of 2.07 and a standard deviation of 0.26 for the pre test (PREAII) and a mean interest

Table 3: The Mean Interest Score and Standard Deviation of Students Taught Mathematics Using Game Based Instructional Technique and the Conventional Approach

Group	No	Pre test		Post test	
		Mean(\bar{X})	SD	Mean(\bar{X})	SD
Experimental	67	2.07	.26	3.43	.10
Control	67	2.13	.23	2.08	.23

Table 4: The Mean Interest Score of Male and Female Students Taught Mathematics Using Game Based Instructional Technique and the Conventional Approach

Group	No	Pre-test		Post-test	
		Mean	SD	Mean	SD
Experimental					
Male	32	2.02	.24	3.42	.08
Female	35	2.25	.17	3.43	.12
Control					
Male	37	2.11	.29	1.96	.23
Female	30	2.01	.21	2.21	.13

score of 3.43 and a standard deviation of 0.10 for the post test (POSTAII). For the control group (conventional method) it was observed that they had a mean interest score of 2.13 and a standard deviation of 0.23 for the pre test (PREAII) and a mean interest score of 2.08 and a standard deviation of 0.23 for the post test (POSTAII).

Research Question 4: What are the mean interest scores and standard deviation of male and female students taught using game-based instructional technique?

Table 4 shows that the male students in the experimental group had a mean interest score of 2.02 and a standard deviation of 0.24 in pre test (PREAII) and a mean interest score of 3.42 and a standard deviation of 0.08 in post test (POSTAII). On the other hand, from the same table, the female students in the experimental group had a mean interest score of 2.25 and a standard deviation of 0.17 in pre test (PREAII) and a mean interest score of 3.43 and a standard deviation of 0.12 in post test (POSTAII).

For the male and female students in the control group, it could be seen that the male students had a mean interest score of 2.11 and a standard deviation of 0.29 in pre test (PREAII) and a mean interest score of 1.96 and a standard deviation of 0.23 in post test (POSTAII). On the other hand, from the same table, the female students in the control group had a mean achievement score of 2.01 and a standard deviation of 0.21 in pre test (PREAII) and a mean achievement score of 2.21 and a standard deviation of 0.13 in post test (POSTAII).

Table 5: Summary of ANCOVA Result for AAT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	29463.439 ^a	4	7365.860	117.133	.000
Intercept	8815.062	1	8815.062	140.178	.000
Pre	2142.664	1	2142.664	34.073	.000
Group	24343.608	1	24343.608	387.115	.000
Gender	217.219	1	217.219	3.454	.065
group * gender	265.552	1	265.552	4.223	.082
Error	8112.121	129	62.885		
Total	566025.000	134			
Corrected Total	37575.560	133			

Hypothesis 1: There is no significant difference among the mean achievement scores of students taught Algebra (mathematics) using game-based instructional technique and those taught without the method, as measured by the Algebra Achievement Test (AAT).

From table result of the analysis of table 5, it shows that there is a significant difference in the mean achievement scores of students taught algebra using game-based instructional technique and those taught the same topics using the conventional approach since the significant value of .000 is less than the $p < 0.05$. In other words the null hypothesis of no difference was rejected.

Hypothesis 2: There is no significant difference between mean achievement scores of male and female students taught Algebra (mathematics) using game-based instructional technique, as measured by the Algebra Achievement Test (AAT).

The result from table 6 shows that gender was significant since the significant value of .001 is less than the $p < 0.05$. Thus, the null hypothesis of no difference was rejected since gender was significant.

Hypothesis 3: There is no significant difference in the mean interest scores of the students exposed to the game-based instructional – technique and control group, as measured by the Algebra Interest Inventory (AII)

The result of the analysis on Table 7 shows that treatment was significant since the significant value of .000 is less than the $p < 0.05$. Hence, the hypothesis of no difference in the mean interest scores of students was rejected.

Table 6: Summary of ANCOVA Result (AAT) for Male and Female Students Taught Using Game-Based Instructional Technique

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4411.975 ^a	2	2205.987	64.591	.000
Intercept	3610.189	1	3610.189	105.707	.000
Pre	3895.575	1	3895.575	114.063	.000
Gender	459.180	1	459.180	13.445	.001
Error	2185.786	64	34.153		
Total	403225.000	67			
Corrected Total	6597.761	66			

Table 7: Summary of ANCOVA Result for AII

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	62.606 ^a	4	15.651	660.345	.000
Intercept	10.187	1	10.187	429.813	.000
Pre	.081	1	.081	3.432	.066
Gender	.497	1	.497	20.973	.000
Group	57.360	1	57.360	2420.063	.000
gender * group	.590	1	.590	24.885	.000
Error	3.058	129	.024		
Total	1083.167	134			
Corrected Total	65.663	133			

Hypothesis 4: There is no significant difference in mean interest scores of male and female students exposed to the game-based instructional technique, as measured by the Algebra Interest Inventory (AII).

The result from table 8 shows that gender was not significant since the significant value of .437 is greater than the $p < 0.05$. Thus, the null hypothesis of no significant difference for gender was not rejected.

Table 8: Summary of ANCOVA Result (AII) for Male and Female Students Taught Using Game-Based Instructional Technique

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.041 ^a	2	.020	2.152	.125
Intercept	5.822	1	5.822	613.907	.000
Pre	.040	1	.040	4.240	.044
Gender	.006	1	.006	.611	.437
Error	.607	64	.009		
Total	790.200	67			
Corrected Total	.648	66			

Hypothesis 5: There is no interaction effect of gender and method on achievement of students as measured by the Algebra Achievement Test (AAT).

The result on table five above shows that the interaction effect due to method and gender was not significant since the significant value of .082 is greater than the $p < 0.05$. thus the null hypothesis of no significant interaction effect between method and gender on students achievement was not rejected.

Hypothesis 6: There is no significant interaction effect between method and gender on students' interest in algebra, as measured by the Student Algebra Interest Inventory (AII).

The result on table 7 shows that shows that the interaction effect due to method and gender was not significant since the significant value of .000 is less than the $p < 0.05$. Thus, the null hypothesis of no significant interaction effect between method and gender on students' interest was rejected.

6. Discussion

Research questions one were intended to find out the mean achievement scores of students taught algebra using game-based technique and their counterparts taught using the conventional method. The analysis of the result in table one shows that the mean achievement scores of students in the experimental group was higher than those in the control group having mean difference of 29.03 and 0.98 respectively. This was further confirmed by the result in table 5 for hypothesis one which intends to find out if there exist a significant difference between the mean achievement scores of the two groups. Analysis of table 5 shows that method was a significant factor in students' achievement in mathematics. Hence, students taught using game-based method performed better than

those taught using the conventional method. This in general reveals that the method used in teaching mathematics can produce differential effects on students with respect to their achievement. This supports other findings by other researchers like Adeyemi and Ajibade (2011) and Olubola and Aladgana (2003) where the use of new method as experimental treatment produced better result.

Analysis of result in table two for research question two which intends to find out the mean achievement scores of male and female students taught algebra using game-based technique. The result though revealed that both male and female students in the experimental group gained from the method used, it also revealed that the male performed better than their female counterparts. This was further confirmed by the result in table 6 for hypothesis two which intends to find out if there exists a significant difference between the mean achievement scores of male and female students in the experimental group. Analysis of table 6 shows that gender was a significant factor in students' achievement in mathematics. Hence, the male students taught using game-based method performed better than females taught using the same method.

This result is in compliance with the findings of some other earlier researches which revealed a significant difference in the achievement of male and female students in mathematics in favour of male Kurumeh and Achor (2008), Bassey, Joshua and Asim (2008). However, this result was contrary to the early findings of Okigbo and Okeke (2013) which indicated that there was no significant difference between the achievement of male and female students in mathematics.

Result from table 3 for research question three shows that that there was a higher mean interest score for the group taught using the game method over the group taught using the conventional method. This was further confirmed by the result in table 7 for hypothesis three which intends to find out if there exists a significant difference between the mean interest scores of the two groups. Hypothesis 5 sought to find out whether there existed a significant interaction effect between the teaching method and gender on students in algebra. The findings on table 5 showed that there was no significant interaction effect between teaching method and gender. Hypothesis 6 sought to find out whether there existed a significant interaction effect between method and gender in students interest in algebra. The findings in table 6 showed that there was no interaction effect between method and gender on students' interest on algebra. The result in table 4 for research question four which intends to find out the mean interest scores of male and female students taught algebra using game-based technique. The result revealed that both male and female students in the experimental group gained from the method used, it also revealed that there was no noticeable difference in the interest scores of the male and female students in the group having a mean difference of 0.01. This was further confirmed by the result in table 8 for hypothesis four which intends to find out if there exists a significant difference between the mean interest scores of male and female students in the experimental group. The result shows that gender was not significant. This result supports the findings of Adaramola (2007) and Adeyemi and Ajibade (2011) that increase in achievement can bring about increase the students interest in mathematics.

7. Conclusion

The findings of this study have a number of implications for students, mathematics teachers, curriculum planners, educational administrators, higher institutions, authors and publishers of mathematics text books, ministry of education, post primary school board, state and federal government.. Since there was a significant improvement in the achievement of students taught using game-based method, students should be encouraged to learn algebra by using the game-based method. Mathematic teachers has a lot to do by introducing the use of games in teaching and learning process since the mean achievement scores of students taught using the game based method was higher than those taught using the conventional method.

References

- [1] Abakpa, B.O. & Iji, C.O. (2011). Effect of mastery Learning On Senior Secondary School Students' achievement in geometry. *Journal of Science Teachers Association of Nigeria*, 1, 165–176.
- [2] Adaramola, M. O. (2007). The effect of mathematical games on students' attitude in mathematics in secondary schools. *The African Symposium: An online Journal of African Educational Research Network*, 7, 158–165.
- [3] Adeleke, M. A. (2008). Strategic improvement of mathematical problem-solving performance of secondary school students using procedural and conceptual learning strategies. *The African Symposium: An online Journal of African Educational Research Network*, 8, 143–149.
- [4] Adeyemi, B. A. & Ajibade, Y.A. (2011). The comparative effects of simulation game and brainstorming instructional strategies on junior secondary school students' achievement in social studies in Nigeria. *African Research Review*, 5, 64–80.
- [5] Agwagah, U.N.V. (2001). The teaching of number bases in junior secondary school mathematics: The use of base board. *ABACUS: Journal of Mathematical Association of Nigeria*, 26, 1–7.
- [6] Ale, S.O. & Adetula, L.O. (2005), Mathematics improvement project (NMC-MIP): A way to enhance student performance in mathematics, *Nigerian journal of professional Teachers*, 1, 17–24.
- [7] Amazigo J.C. (2000). Mathematics Phobia: Diagnosis and Prescription. National Mathematical Centre First Annual Lecture, Abuja.
- [8] Aremu, A. (1998). Strategies for improving the performance of female pupils in Mathematics *African Journal of Education Research*, 5, 77–88.
- [9] Ayotola, A. (2003). Adapting Ludo as a Resource Material for Effective Mathematics Communication in Primary School. STAN 44th Conference Proceedings, 261–263.

- [10] Bassey S. W., Joshua M. T. & Asim A E. (2008). Gender differences and mathematics achievement of rural senior secondary students in Cross River State, Nigeria. Proceedings of International Conference to Review Research in Science, Technology and Mathematics Education (epiSTEME-2), Mumbai, India.
- [11] Brian, J. (2010). Studying algebra. Retrieved from <http://www.articlesbase.com/>
- [12] Eze, F. B. (2006). Effect of Mathematical Scrabble Games on Achievement and Interest in Computational Skills in JSS. Unpublished M.ED Thesis, University of Nigeria Nsukka.
- [13] Ezeamaenyi O. & Alio B. C. (2004). The Roles of Mathematics in Information Technology: Implication for the Society. *ABACUS: Journal of the Mathematical Association of Nigeria*, 29, 7–8.
- [14] Ezeugo, N. C. & Agwagah, U. N. V. (2000). Effect of concept mapping on students achievement in Algebra: Implication for secondary mathematics education in the 21st century. *ABACUS: Journal of the Mathematical Association Nigeria*, 25, 1–12.
- [15] Federal Republic of Nigeria (2004). *National Policy on Education*. Lagos: Federal Government Press.
- [16] Iloputaife, E.C. (1996). Method and Location as a Factor in School Cognitive achievement on Physics. Unpublished M.ED Thesis, University of Nigeria Nsukka.
- [17] Imoko, B. I., & Agwagah, U. N. V. (2006). Improving students' interest in mathematics, through the concept mapping technique. A focus on gender. *Journal of Research in Curriculum and Teaching*, 1, 30–38.
- [18] Iyi, U. (2011). Results of WAEC Examination 2010. *Daily Sun News Paper of 11th Aug.*, 2011.
- [19] Kolawole, E. B. & Oluwatayo J. A. (2005). Mathematics for everyday living: Implications for Nigerian Secondary Schools. *ABACUS: Journal of the Mathematical Association Nigeria*, 30, 51–57.
- [20] Kurumeh, S. M., & Achor, E., (2008). Effect of Cuisenaire Rods' approach on some Nigeria primary pupils' achievement in decimal fraction. *Educational Research and Review*, 3, 339–343.
- [21] Kurumeh, M. S. & Imoko, B. I. (2008). Universal Basic Education. A Way Forward for Development of Mathematics Education. *ABACUS: Journal of the Mathematical Association Nigeria*, 33.
- [22] Maduabum, M.A., & Odili, G.A. (2006) Analysis of students' performance in General Mathematics at SSCE level in Nigeria 1991–2002, *J. Res. Curriculum Teach*, 1, 64–68.
- [23] Martin, A. (2000). A National Survey on Teachers Perception of Self-determination and Students Directed Learning. *Journal of Special Education*, 34, 13–18.

- [24] National Mathematics Centre, Abuja.(2009). Mathematics improvement Programme. Retrieved from www.nmcabuja.org/mathematics_improvement_programmes.html.
- [25] Nakpodia, E.D. (2006). *Educational Administration: A New Approach* (2nd Ed.). Warri: Jonokase Publishers.
- [26] Nworgu, B.G. (2006). *Educational research: basic issues and methodology* (3rd ed.). Nsukka: University Trust Publishers.
- [27] Odili, G.A.(2006) Analyses of students performance in Mathematics from 1991-2002. *Journal of Research in Curriculum and Teachings*, 1, 64–68.
- [28] Okafor, O. T. (2002). *Teaching methods of mathematics in secondary schools*. Ibadan: Special Book Ltd.
- [29] Okigbo, E, & Okeke N. F. (2013). Game and analogy: A bi-model for effective instruction in the Nigerian mathematics classroom. *Universal Journal of Education and General Studies*, 2, 175–179.
- [30] Okigbo, E.C. (2010). Comparative effectiveness of mathematical game and instructional analogy as advance organizers on students' achievement and interest in mathematics. Unpublished doctoral dissertation, Nnamdi Azikiwe University, Awka, Nigeria.
- [31] Olubola, S. & Aladgana, F. (2003). Effect of simulation games and computer assisted instruction on performance in primary science. The WEI international academic conference proceedings, Orlands, USA.
- [32] Udaya, C. O. (2010). Gender Issues in International Politics and the MDGS. *Journal of Arts And Social Sciences Review*, 3, 177–184.
- [33] WAEC (2006–2011). West Africa Examination Council Chief Examiners' Report. FCT, Abuja.
- [34] WAEC (2005–2009). West Africa Examination Council Chief Examiner's reports. FCT. Abuja.
- [35] WAEC (2010). West Africa Examination Council Chief Examiners' report. FCT. Abuja.