

EFFECTS OF ALGEBRAIC EQUATION GAME ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN ALGEBRA IN NSUKKA EDUCATION ZONE, ENUGU STATE, NIGERIA

By

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Abstract

This study was designed to determine the effects of algebraic expansion game on secondary school students' achievement in algebra. Two (2) research questions and three (3) null hypotheses guided the study. The design used for the study was non-equivalent control group quasi-experimental design. A sample of three hundred and eighty (380) SSI students drawn from three coeducational senior secondary schools in Nsukka Education zone formed the subjects for the study. Two SSI classes were randomly assigned to experimental and control groups in each of the schools. The students were taught by their normal class mathematics teachers who served as research assistants. Instrument used for the study is Algebra Achievement Test (AAT). The reliability coefficient of AAT was 0.84. The result of the study showed that the Algebraic Expansion Game improved students' achievement in algebra significantly. Secondly, use of the game in algebra instruction depicted gender-balance. Finally, the interaction effect between the teaching approach and gender was not significant on student' achievement. The study recommended among other things, that since the game is found to be facilitative instructional approach for enhancing achievement in Algebra, teachers should adopt it as instructional approach. Mathematics teachers should be encouraged to improvise related materials to make their teaching more meaningful.

Keywords: *Algebra, Games, Achievement and Gender.*

Introduction

Mathematics is a core subject in Nigerian education system and at Secondary School level in particular. According to Iyoke (2015), mathematics is a science visualized in symbols, logical statements, shapes, numerical quantities and arrangement. Mathematic is all around us in our daily lives, including mobile devices, architecture(ancient and modern), art, money, engineering and even sports. Since the beginning of history, mathematics discovery has been at the forefront of every civilized society, even in the most primitive of cultures. The needs of Mathematics arose based on the wants of society. The more complex a society, the more complex the mathematics needs. Primitive tribes needed little more than the ability to count, but also relied on mathematics to calculate the position of the sun and the physics of hunting. For any country engaged in nation building to achieve success, it must first produce logical minds. In other words, if a nation is to achieve socio-economic stability and sustainable development, then education in all areas of knowledge must be considered seriously. Neglect of mathematics works injury to all knowledge, since he who is ignorant of it cannot know the other sciences or the things of the world (Roohi, 2015). Both national and human development, depend largely on the development of science and technology for which Mathematics is the bedrock (Haruna, 2014). No nation can develop scientifically and technologically without proper foundation in school mathematics (Okafor 2005).

Studies in mathematics education showed that mode of instruction, especially at secondary school level are characterized by teacher-centered approach (Obioha, 2006 in Iyoke, 2015). There are greater emphasis on expository method and use of text books instead of engaging students in

critical thinking across subject area and applying the knowledge acquired to real-world situation (Butty, 2001 in Iyoke, 2015). So, no matter how excellent and attractive a teaching and learning approach is, it only becomes more relevant if practical activities are built into the daily teaching and learning experience of students. According to Odusoro (2012), the knowledge of science remains superficial without mathematics. This means that, the position of mathematics in secondary school curriculum in Nigeria is important for scientific development. No wonder Mathematics is a core subject in Nigeria secondary schools. To emphasize the importance of this subject, students at all levels of education must offer it. This is to make student versatile, resourceful, and well- grounded for future life endeavors.

Despite the place of mathematics in the development of our society, many research reports show that the achievement of students in mathematics at all levels of our educational system is poor. In this context, achievement means the cognitive gains of students that can be measured in terms of passes in Mathematics test or examination administered by a teacher or examination body. Recent research reports show that achievement in Mathematics has continued to be low. Students' achievement in Mathematics has remained very low as many of the candidates earn less than 40% (WAEC chief's statement, 2017). Poor achievement of students in mathematics is no longer new to anybody. A study conducted by Maduabum and Odili in Nwabueze (2009) on students' achievement in General Mathematics at the senior school certificate level in Nigeria over twelve years depicted students' poor achievement in mathematics. This was buttressed by Obarakpo (2009) in Iyoke (2015) who stated that achievements of students in senior secondary school mathematics have been on decline from 1997 to 2008. According to Nwabueze(2009), mass failure and consistent poor achievements in mathematics which students have shown over a decade cast serious doubt on country's high attainment of science and technology. According to Zalmon and Wonu (2017), Analysis of achievement of students in general mathematics in the May\June West Africa Senior Secondary Certificate Examination (WASSCE) in Nigeria between 1991 to 2016 indicated abysmal achievement in mathematics, with 27.31% of students obtaining credits and above while 72.69% had pass and below. The observed poor achievement in Mathematics has been a matter of serious concern to all well-meaningful educators.

Gender in mathematics achievement refers to the finding that, on average the two sexes achieve differently in mathematics. There is general belief that male students achieve better than female students in mathematics and algebra in particular. According to Popoola and Ajani (2011) male students perform better than female students in mathematics. It has been observed by Ajayi and Ighoroje, 2010, that registration in science and related courses at the nations' higher institutions is rapidly declining particularly for female students. Ogunkule (2007) discovered that there is significant gender difference in the post-test achievement of the experimental group taught with the help of constructivist strategy in favour of the male students. In contrary, Hyde and Mertz (2009) insisted that girls in United State have reached parity with boys in mathematics achievement, a pattern that is found in some other nations as well.

These poor achievements of students in Mathematics especially its gender imbalanced tendencies, have been blamed on the instructional approach. According to Okoli, (2009) in Onu, (2018) adequate instructional materials means a sufficient sets of materials and intellectual contents designed to serve as the major tool for assisting in the instruction of a subject or course. These items may be provided in a variety of forms, bound, unbound, kit, or package form and may consist of hard backed or soft backed, electronic content, consumables, learning laboratories, manipulative, electronic media, and computer software. Instructional materials facilitate and optimize the attainment of specific instructional objective. For ideal instructional programmed to be attained, appropriate instructional materials must be available. So, failing in mathematics is

beyond perception but as a result of other factors. Okoli, (2009) classified these factors as lack of expertise, teachers experience, teachers qualification, students attitude to mathematics, students background, class size, inadequate use of instructional materials to facilitate teaching and learning of mathematics among other things. There is need therefore, for a search for more appropriate approaches to teaching and learning of Mathematics. According to Eraikhueman (2003) in Iyoke (2015), students dislike certain topics because they feel the topics are difficult and cannot be retained easily. It has also been discovered that some teachers lack techniques and materials for teaching certain topics to the extent that if given choice, they will not teach such topics. One of such areas that teachers and students have problems, based on lack of techniques and materials, is algebra. The WAEC chief Examiners' Reports (2014) complained that many candidates missed full marks because of arithmetic errors in factorization and solution of quadratic function. Roberts (2007) in Iyoke (2015) stated that, for many students, algebraic concepts are more easily grasped with the concrete representation displayed by the tiles. Games may be used to introduce concepts as a prelude to explicit teaching or to practice skill or to consolidate a concept after explicit teaching. According to Boggan, Harper and Whitemire (2012), most valuable learning occurs when students actively construct their own mathematical understanding, which is often accomplished through the use of games. In order to have opportunities to learn mathematics, students need first hand experiences related to mathematics, interactions with other students and adults concerning these experiences and time to reflect on the experiences (Seefeldt & Wasik, 2006). It is important for students to have a variety of materials to manipulate and opportunity to sort, classify, weigh, stalk and explore if they are to construct mathematical knowledge (Boggan, Harper & Whitemire, 2011).

It is based on this outcry of lack of materials and techniques, poor achievement, in the area of algebra that the researcher viewed Algebraic Expansion game timely as instructional material. Algebraic Expansion game is a mathematical game for expansion of algebraic process. It is an evaluation game that combines mathematical skills with a competitive strategy. It is a highly motivational skill-review exercise that involves problem solving strategy for expansion of algebraic expression. This game can be played by two or more players. The materials used for the game include: $(X + Y)$ square board, 30 cards measuring 5cm by 9cm each containing values for X and Y. The 30 cards are reshuffled properly. The first player A shares the cards into three (3); one (1) for him, one for player B and the remaining one faced downward on the play table. The player A plays a card of his choice say $X = 2, Y = 1$. Then player B substitutes the value into the square board. If he gets the answer correctly, he scores 1 point. Otherwise, player A substitutes it and gets a bonus 1 point. Now player B plays his own card say $X = 2a, Y = b$ for player A to substitute into the square board and find the answer. The game continues until the shared cards are finished. The player with highest number of points becomes the winner.

Statement of the Problem

Every academic discipline has its peculiar problem. However, many evidences show that students' achievements in the subject over the years have been consistently low. There are many outcries over students' poor achievement in mathematics and algebra in particular. This deteriorating state of achievement may be due to abstract concepts, parental factors, students' poor self-esteem, instructional approach like expository approach. Despite studies like target task approach, models and simulation approach, laboratory approach, concept mapping technique, heuristic approach, delay formalization etc, poor achievement continues. In an attempt to seek lasting solution to the problems, the researcher investigated how algebraic expansion game will improve students' achievement in algebra.

Purpose of the Study

The purpose of the study was to determine the effects of algebraic expansion game on secondary school students' achievement in algebra. Specifically, the study was designed to:

1. determine the difference in mean achievement scores of students taught algebra with algebraic expansion game and those taught with expository approach
2. examine the achievement of male and female students taught algebra with algebraic expansion game

Scope of the Study

This study was limited to expansion of algebraic expressions. SS1 students from Nsukka education zone in Enugu state, Nigeria were used for the study because expansion of algebraic expression is in SS1 syllabus (Federal Ministry of Education FME, 2004). Algebra was chosen due to the conceived abstraction of the concept as depicted earlier.

Research Questions

This study was guided by the following research questions:

1. What are the mean achievement scores of students taught algebra with the game (experimental group) and their counterparts taught with expository approach (control group) in both pretest and post test?
2. What are the mean achievement scores of male and female students taught algebra in experimental group?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 levels of significance:

- HO₁ there is no significant difference between the mean achievement scores of students in the experimental group and their counterparts in control group.
- HO₂ there is no significant difference between the mean achievement scores of male and female students in experimental group.
- HO₃ the interaction effect of method and gender on students' achievement mean scores is not significant.

Methodology

The design for this study was the non-equivalent control group quasi-experimental design. According to Ozofor (2012), this design is often used when it may not be possible for the experimenter to assign subjects randomly to groups in a class room setting. Thus intact classes were randomly assigned to experimental and control groups so as not to alter the school programme. The study was carried out in Nsukka Education zone of Enugu State, Nigeria. The zone has three Local Government Areas (LGA), Igbo Etiti LGA, Nsukka LGA and Uzouwani LGA. The population of this study comprised all the 3915 senior secondary one (SS1) in 49 public coeducational secondary schools in the zone, consisting of 1928 male students and 1987 female students (Post Primary School Management Board (PPSMB) Nsukka zone 2018).

The subjects of this study were 380 senior secondary school one (SS1) students from three (3) public coeducational schools in Nsukka zone. These students consist of 196 male students and 184 female students. Simple random sampling technique (balloting) was used to draw one school each from each local government in the zone. Coeducational schools were considered appropriate because gender is a variable in the study. The consideration for adopting public schools was based on the fact that teachers in public schools were recruited by the same body – Post Primary School Management Board (PPSMB). The schools use the same prescribed syllabus in Mathematics. These students were also admitted through the same state ministry of

education Enugu State, Nigeria. In each of the schools used, two (2) intact classes were used giving rise to six classes in all. This was to enable the researcher randomly assign the two classes experimental and control groups respectively. The sample size of 192 students made up of 95 males and 97 female students formed the experimental groups, and 188 students made up of 101 male students and 87 female students formed the control groups.

The researcher used Algebraic Achievement Test (AAT) for data collection. The AAT consists of 20 multiple choice test items each with four options, developed by the researcher to assess students' cognitive achievement in the topics treated both in pre testing and post testing. The Algebraic Achievement Test (AAT) was subjected to the content validation. Kuder-Richardson 20 (k-R20) was used to estimate the reliability of AAT and the reliability index was 0.84.

During treatment, both students from experimental and control groups were pre tested in all the three schools with the final draft of AAT on the same day before any treatment by the research assistants. The items were retrieved from the students after the pre-test. The research assistants commenced treatment in the schools. The treatment here implies teaching with lesson plan prepared by the researcher for the use of algebraic expansion game as an approach for experimental group and use of expository approach for control group. The treatment took place on different days. That was to enable the researcher observe the experimentation. Immediately after the treatment, the students in both groups were post tested the same day in each school. The AAT items were scored 20 marks in all. Each item answered correctly by the subject attracted one (1) mark, while those failed attracted no mark. The achievement scores obtained after administration of the AAT were analysed using arithmetic mean and standard deviation for the research questions, while Analysis of covariance (ANCOVA) was used for testing the research hypotheses at 0.05 levels of significance.

Results

Research Question 1: What are the mean achievement scores of students taught algebra with the game (experimental group) and their counterparts taught with expository approach (control group) in both pretest and post test?

Table 1: Mean Achievement Scores and Standard Deviation of Experimental and Control Groups in AAT

Groups	N	Pre-AAT		Post-AAT		Mean Diff.
		Mean	SD	Mean	SD	
Experimental	190	7.82	2.414	13.34	3.448	5.52
Control	188	7.37	3.183	9.36	3.488	1.99

From the data in Table 1 above, the pre-AAT mean achievement scores and standard deviation (SD) of the experimental group were 7.82 and 2.414 respectively while those of the control group were 7.37 and 3.183 respectively. In post-AAT, the mean achievement scores and standard deviation (SD) of experimental group were 13.34 and 3.448 respectively while those of the control group were 9.36 and 3.488 respectively. This result showed that though, learning took place in both groups, experimental group achieved better than their counterparts in control group as indicated by the mean difference of the two groups.

Research Question 2: What are the mean achievement scores of male and female students taught algebra in experimental group?

Table 2: Mean Achievement Scores and Standard Deviation of Male and Female Students in Experimental Groups measured with AAT.

Gender	N	Pre-AAT		Post-AAT		Mean Diff.
		Mean	SD	Mean	SD	
Male	94	7.80	2.517	13.15	3.339	5.35
Female	96	7.84	2.519	13.50	3.544	5.66

From the data in Table 2 above, the pre-AAT mean achievement scores and standard deviation (SD) of male students were 7.80 and 2.517 respectively while those of female students were 7.84 and 2.519 respectively. In post-AAT, the mean achievement scores and standard deviation (SD) of male students were 13.15 and 3.339 respectively while those of female students were 13.50 and 3.544 respectively. This result showed that male and female students achieved almost equally as depicted by mean difference of the two groups.

Research Hypotheses

- HO₁ there is no significant difference between the mean achievement scores of students in the experimental group and their counterparts in control group at $P < 0.05$.
- HO₂ there is no significant difference between the mean achievement scores of male and female students in experimental group at $P < 0.05$.
- HO₃ the interaction effect of method and gender on students' achievement mean scores is not significant at $P < 0.05$.

Table 3: Analysis of Covariance (ANCOVA) of Students' Achievement Scores

Source of variance	Sum of squares	Df	Mean square	Fcal	Sig	Decision at 0.05 level
Corrected model	2732.715 ^a	4	683.179	78.940	0.000	S
Intercept	1612.522	1	1612.522	186.323	0.000	S
Covariates	1259.716	1	1259.716	145.557	0.000	S
Groups	1231.225	1	1231.225	142.265	0.000	S
Gender	2.315	1	2.315	0.267	0.605	NS
Group*Gender	4.02	1	4.020	0.465	0.496	NS
Error	3219.45	372	8.654			
Total	57375	377				
Corrected total	5952.164	376				

Discussion, Conclusion and Recommendations

The data in table 3 above, tested hypotheses 1, 2 and 3. The result showed f-calculated of 142.265, 0.267 and 0.465 for groups, gender and two-way interaction on achievement between group and gender respectively.

In hypothesis one, the F-calculated of 142.265 has an associated probability of 0.000 which is less than 0.05. The null hypothesis of no significant difference is rejected. This means that there is significant difference between the mean achievement scores of students taught algebra with Algebraic Expansion Game and those taught with expository approach. The direction of the difference is in favour of experimental group which had a higher mean post-AAT achievement score as shown in Table 1 above.

In hypothesis two, the F-calculated of 0.267 has an associated probability of 0.605 which is greater than 0.05. This means that gender as a factor does not significantly influence achievement of students taught algebra with Algebraic Expansion Game. Hence, hypothesis two is not rejected because the difference in mean achievement scores between the male and female students taught algebra with Algebraic Expansion is no significant.

In hypothesis three, the F-calculated of 0.465 for two-way interaction between group and gender has an associated probability of 0.496 which is greater than 0.05. This means that there is no significant interaction effect between group and gender on students' achievement. Therefore, the hypothesis three is not rejected.

In conclusion, the results in the table 1 showed that the students in the experimental group achieved higher than those in control group. This was confirmed by result of hypothesis one which indicated that method is a significant factor in students' achievement in algebra because students taught using Algebraic Expansion Game achieved better than those taught with expository approach. This finding supported Seefeldt & Wasik (2006), Roberts (2007), Boggan, Harper &Whitemire (2012), Iyoke (2015) and Onu (2018) whose studies showed that cognitive achievements of students in mathematics and algebra in particular largely depends on teachers' instructional approach. Evidently, the result implicated a strong relationship between instructional strategy and achievement in algebra.

In table 2, the descriptive statistics showed that both male and female students in experimental group achieved higher due the game use for without gender disparity in the achievement. This findings supported Hyde and Mertz (2009) whose study indicated that girls in United State have reached parity with boys in mathematics achievement, a pattern that is found in some other nations as well. However, the finding contradicted Ogunkule (2007) and Popoola & Ajani (2011) who discovered that there are gender differences in mathematics students' achievements in favour of male students.

On the bases of the findings, the researcher recommended that Algebraic Expansion Game should be used by mathematics teachers in teaching algebra. Also, mathematics teachers should be retrained through seminars, workshops, and in-service training on how to use the approach in the teaching of algebra.

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