

Card Games and Algebra Tic Tacmatics on Achievement of Junior Secondary II Students in Algebraic Expressions

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ABSTRACT

This study investigated the Card Games and Algebra tic-Tacmatics on Junior Secondary II Students' Achievement in Algebraic Expressions. Three research questions and three null hypotheses guided the study. The study adopted the pre-test, post-test control group design. A total of two hundred and forty (240) Junior Secondary School II students were used as sample for this study. The experimental group was taught using games while the control group was taught using the conventional (lecture) method. Algebraic Achievement Test (AAT) was used to collect data for this study. AAT was validated by three experts in mathematics education and measurement and evaluation respectively. The reliability index of AAT was 0.79. Mean and standard deviation were used to answer the research questions while ANCOVA was used to test the hypotheses at 0.05 level of significance. The findings of the study showed among others that there was a significant difference between students taught algebraic expressions with games and those taught without games, there was also a significant difference between the achievement of males and females taught algebraic expressions with games and those taught without games in favour of the males.

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1. INTRODUCTION

In any human activity, there exists an element of mathematics which could be inform of Algebra, Calculus, Geometry, Trigonometry or Statistics and they use signs, symbols and/or proofs to describe relationship(s). Hence, Mathematics as a school subject is taught primarily for the development of thinking skills, reflections on oneself, environment, social issues and organizing one's experience for possible solution(s) to problems [1]. Otunu-Ogbisi (2009) defined mathematics teaching and learning as the act of imparting and acquiring of skills, knowledge, aptitude, abilities and attitude capable of making the individual functional and productive for all round achievement of a nation's developmental goals [2]. Odumosu, Oluwayemi and Olatunde (2012) described mathematics as an essential ingredient in manufacturing industries, economic activities, bride of sciences, chief bride's maid of social sciences, ladies in waiting for engineering, cosmetology of arts and unavoidable servant of management sciences [3]. It is not surprising that because of this, mathematics is recommended as a core subject in both primary and secondary school in Nigeria and many countries of the world. As Anugwo (2011) stated, this is to enable students acquire and broaden their knowledge, skills, and outlook in mathematics because of its applicability to many areas of life [4]. It therefore means that mathematics can be applied in every facets of life even in the small-scale business enterprises which is the life wire of every economic sector. The application of mathematics to problem areas depends on the understanding of the concepts and the principles of mathematics by the problem solver. This

would enable the students experience, discover, discuss and change the misconception of mathematics as an abstract and difficult to learn subject, especially as it concerns algebra related topics.

Algebra, as an aspect of mathematics means finding the unknown or putting real life problems into equations and then solving them [5]. It could also be seen as a branch of mathematics that substitutes letters for numbers [6]. Algebra can include real numbers, complex numbers, matrix vectors, etc [7]. It is the generalized arithmetic [8] which every economic sector need as the medium through which mathematics problems either words or mechanical are semantically and systematically translated, written and manipulated to give the desired logic (answer) that is been interpreted for the given situation [9].

Educators and Mathematicians consider algebra to be one of the most important areas of school mathematics [10],[11]. In mathematics, an algebraic expression is an expression built up from constants, variables, and a finite number of algebraic operations (addition, subtraction multiplications, division and exponentiations) by an exponent that is a rational number [11]. Some of the examples of algebraic

expression are: $3x^2 - 2xy + c$ and $\frac{1-x^2}{1+x^2}$.

Algebra forms an important aspect of the mathematics curriculum. It is disheartening to say that students' achievements in mathematics at both internal and external examinations have reportedly been poor especially in algebraic processes [10],[12]. Kurumeh and Eniayeju (2008) attributed this ugly trend of students' poor academic achievement in mathematics to a very weak mathematics foundation which begins in the primary level and is carried over to the junior secondary, and is culminated in senior secondary [13]. Amos (2001) posited that the simple cause of mass failure in, mathematics academic performance of most students in many countries including Nigeria is the inability of mathematics educator's to do what they are supposed to do in terms of method of teaching [14].

Research evidence agreed that inadequate method of instruction is a problem militating against the understanding of mathematical concepts. Odili (2006) and Galadima (2002) posited that poor quality of instructional technique employed by the teachers is one of the major causes of poor achievement among secondary school students in mathematics [15],[16]. The use of irrelevant teaching methods and absence of mathematics resource materials are some of the problem areas in the teaching and learning of mathematics that militate against students taking career choice in furthering studies requiring the knowledge of mathematics. Agwagah (2004) stated categorically that traditional mathematics teaching is still the norm in our nation's schools and has continued to dominate the mathematics classroom [17]. In traditional teaching, students acquire mathematical skills by imitating demonstration by the teacher and the textbook. Furthermore, in traditional mathematics instruction, the teacher on daily basis shows the students several examples of how to solve a certain type of problem and have them practice this method in the class and in homework. This rote memorization is not only ineffective but also seriously stunts students' interest and growth in mathematical reasoning and problem solving skills [18]. This teacher-directed instruction, rote memorization, drill and verbal recitation and worksheet completion approaches most of the time fail to develop students' generic skills and interest. Amos suggested that mathematics teaching should be structured such that knowledge is built on a foundation already possessed, encourage students to learn by doing, ensuring that learning grows out of useful experiences and experimentations, by effective use of mathematical manipulation that stimulates cognitive, affective and psychomotor domains' development. This can be achieved with the use of appropriate mathematical games to teach different mathematical concepts at the secondary school level.

Mathematical games also called educational games have been defined as an enjoyable social activity with goals, rules, and regulational objectives [19]. Mathematical games are one of the strategies of the National Mathematical Centre (NMC) for improving the teaching and learning of mathematics in schools. Mathematical game approach involves two or more students working together to find a solution to a given mathematics problem. In a mathematical game, the winner, the loser and the spectator(s) are all expected to learn the mathematics concept being practiced in the game. Educators and researchers have recommended the use of mathematical games in teaching and learning of mathematics because it is found to sustain and develop students' interest and achievement in mathematics.

According to Anugwo (2011), mathematics games encourage students to discuss mathematical strategies with the others including their peers, teachers and parents [4]. As they are joking around, interest is captured and unusual solutions (solutions that were not easy to come by when the conventional teaching method is being used) to problems are achieved. Mathematical games can take the forms of puzzles, magic tricks, fallacies paradoxes, or any type of mathematics which provides amusement or curiosity [10]. They bring joy to the learner, breakdown resistance to learning by reducing tension, clearing boredom, and providing an environment where the student can develop skills and acquire more knowledge. They also

stimulate mathematical thinking and generate excitement and spirit of individualism, co-operation and competition [11]. This work found whether they enhance mathematics achievement.

The issue of mathematics achievement and gender has attracted the attention of some researchers. The performance of both male and female students vary from place to place, but the most remarkable differences may occur due to spatial and mechanical tests and such ability might be attributed to the cultural influences of the students background [20]-[22]. A substantial amount of research in learning and teaching of algebra is focused on the effectiveness of manipulative [7],[23] and computer applications [6] on students ability to generalize patterns and solve algebraic relations. Although these studies have produced exciting results, the majority of them favor the use of computer applications in developing students' abilities and interest in solving algebraic problems than teacher- developed games. The latter can be used in situations where these computer applications (for example in rural areas) may not be available or scarce. Hence this study saw the need to find the actual effect of mathematical games to students' achievement in algebra.

1.1. Specific Purposes of the Study

- i. Effect of mathematical games on the mean achievement scores of junior secondary school II students in algebraic expressions,
- ii. Effect of the mathematical games on the mean achievement scores of male and female students in junior secondary school II students algebraic expressions, and
- iii. Interaction effect of method and gender on the mean achievement scores of junior secondary school two students in algebraic expressions.

1.2. Research Questions

- i. What is the effect of mathematical games on the mean achievement scores of junior secondary students in algebraic expressions?
- ii. What is the effect of mathematical games on the mean achievement scores of male and female students in algebraic expressions?
- iii. What is the interaction effect of method and gender on the mean achievement scores of students in algebraic expressions?

1.3. Null Hypotheses

- Ho₁: There was no statistically significant difference in the mean achievement scores of students taught algebraic expressions with mathematical games and those taught without games.
- Ho₂: There was no statistically significant difference in the mean achievement scores of male and female students taught algebraic expressions with mathematical games and those taught without games.
- Ho₃: There was no statistically significant interaction effect between method and gender of the students in their mean achievement scores in algebraic expressions.

2. RESEARCH METHOD

The design adopted for this study was quasi-experimental design which used a pre-test, post-test, non-randomized control group. The population was made up of 1689 Junior Secondary Two (JS2) Students in 21 public secondary schools in Onicha Local Government Area of Ebonyi State, Nigeria. A total of two hundred and forty (240) JS2 students were used as sample for the study. Simple random sampling technique of balloting was used to select (4) schools out of the 21 schools and also two schools each from the 4 schools for the experimental and control groups. Two intact classes were simple randomly selected from the 4 schools for each group. Experimental group (taught with games) were 136 students and control group (taught with conventional lecture method) were 104. The instrument for data collection was an Algebraic Achievement Test (AAT) developed by the researchers which contains questions from Algebraic Expressions, Simple Linear Algebraic Equations and Algebraic Expansions (JSS11 topics). Card games suitable for the teaching of these topics were used and algebra tic-tac-matics was used in teaching algebraic expansions. AAT was a 50 multiple choice objective questions with options A-D. One option is the key the rest are distracters. It is 2marks per question. The instrument was used as pre-test and after the treatment was administered, the same instrument was changed in terms of color and position of items and used as post-test.

The instructional procedure (card games and algebra tic-tac-matics and lesson plan) also developed by the researchers were validated by three (3) Mathematics specialists and two (2) experts in Measurement and Evaluation. The instrument and the tools were trial tested in 2 schools outside the area of the study. The reliability of AAT was established using Kuder-Richardson 20 Formula and had a reliability index of 0.79. Descriptive statistics of Mean and Standard Deviation were used to answer the research questions while

Analysis of Covariance (ANCOVA) was used to test the hypotheses at alpha level of 0.05 using pre-test scores as covariates.

In order to control teacher quality variable, teachers in both groups were trained by the researchers. The regular classroom teachers taught the two groups (experimental and control groups). The experimental group was taught with lesson plan on games while the control group was also taught the same units (algebraic fractions, simple linear algebraic equations and algebraic expansions) from JS2 mathematics syllabus for a period of six weeks involving four contacts of 40 minutes each week.

3. RESULT AND DISCUSSION

As indicated in Table 1, the experimental group had an adjusted mean score of 72.51 and a standard deviation of 10.52. The control group had an adjusted mean of 54.08 and a standard deviation of 7.04. The scores show that the experimental group achieved better than the control group.

Table 1. Mean and Standard Deviation of Achievement Scores of Experimental and Control Groups in Algebraic Expressions

Group	Mean	SD	N
Experimental	72.51	10.52	136
Control	54.08	7.04	104

In Table 2, the male students had an adjusted mean score of 79.44 and a standard deviation score of 8.14 while their female counterparts had an adjusted mean score of 64.95 and a standard deviation score of 7.06. The scores indicate that the male students performed better than their female counterparts when taught with mathematical games.

Table 2. Means and Standard Deviation of Post Test Achievement Scores of Male and Female Students in Algebraic Expressions

Group	Mean	SD	N
Male	79.44	8.14	71
Female	64.95	7.06	65

In Table 3, the mean scores for the experimental group showed that the male students had an adjusted mean score of 79.44 and a standard deviation score of 8.14 while the female students had an adjusted mean score of 64.95 and a standard deviation score of 7.06. This showed that games favored the male students more than their female counterparts. For the control group, the male students had an adjusted mean score of 55.82 and a standard deviation score of 6.92 while the female students had an adjusted mean score of 52.04 and a standard deviation score of 6.69.

Table 3. Mean and Standard Deviation Score of the Students in the Experimental and Control Groups Based on Interaction between Method and Gender

Group	Gender	Mean	SD	N
Experimental	Male	79.44	8.14	71
	Female	64.95	7.06	65
Control	Male	55.82	6.92	56
	Female	52.04	6.69	48

The analysis of covariance result presented in Table 4 shows that there is significant difference in achievement of students between the experimental group and the control group ($p < 0.05$). Hence, the null hypothesis which states that there is no statistically significant difference in the mean achievement scores between the students taught with games and those taught without games was rejected. This implies that games (Card Games and Algebra Tic-Tacmatics) significantly enhanced students' achievement in algebraic expressions. This further indicates that the experimental group achieved significantly better than the control group. This thus, justified the group's adjusted mean scores in table 3 in which the experimental group scored higher than the control group. Thus, the use of games significantly enhances students' achievement more than the non-use of games.

Table 4. Analysis of Covariance (ANCOVA) Results of the Experimental and Control Groups with Pretest Scores as Covariates

Source of Variation	Sum of Squares	Df	Mean Squares	F	Sig.
Corrected Model	28326.308	4	7081.577	141.468	.000
Intercept	18465.428	1	18465.428	368.883	.000
Pretest	804.915	1	804.915	16.080	.000
Treatment group	15265.399	1	15265.399	304.956*	.000
Gender	4023.328	1	4023.328	80.374	.000
Method and Gender	1318.878	1	1318.878	26.347	.000
Error	11763.542	235	50.058		
Total	1039324.000	240			
Corrected Total	40089.850	239			

*Significant at 0.05 alpha level

The analysis in Table 5 shows that there was a significant difference in academic achievement of male and female students taught algebraic expressions with games and those taught without games ($p < 0.05$). Hence, the null hypothesis which states that there was no statistically significant difference in achievement in algebraic expressions between male and female students taught with games and those taught without games is rejected. This implies that games have significant effect on the academic achievement of male and female in algebraic expressions. From the result in Table 5, the games favored significantly the male students than their female counterparts. That is, the male students achieved better than their female counterparts.

Table 5. Analysis of Covariance (ANCOVA) Results of Male and Female Students Taught with Games and those Taught without Games

Source of Variation	Sum of Squares	Df	Mean Squares	F	Sig.
Corrected Model	28326.308	2	7081.577	141.468	.000
Intercept	18465.428	1	18465.428	368.883	.000
Pretest	804.915	1	804.915	16.080	.000
Treatment group	15265.399	1	15265.399	304.956	.000
Gender	4023.328	1	4023.328	80.374*	.000
Method and Gender	1318.878	1	1318.878	26.347	.000
Error	11763.542	131	50.058		
Total	1039324.000	136			
Corrected Total	40089.850	135			

*Significant at 0.05 alpha level

In Table 6, the analysis showed a significant interaction effect between the method used and the gender of the students ($p < 0.05$). Thus, the null hypothesis which states that there was no statistically significant interaction effect between the method and gender of the students in the mean achievement scores in algebraic expressions was rejected. This means that the facilitating effect of games on students' achievement scores is not the same at all levels of gender. The analysis in Table 6 shows that the interaction effect between method and gender favored the male students more than the female students. That is, the male students achieved better than their female counterparts.

Table 6. Analysis of Covariance (ANCOVA) of the Interaction between Method and Gender

Source of Variation	Sum of Squares	Df	Mean Squares	F	Sig.
Corrected Model	28326.308	4	7081.577	141.468	.000
Intercept	18465.428	1	18465.428	368.883	.000
Pretest	804.915	1	804.915	16.080	.000
Treatment group	15265.399	1	15265.399	304.956	.000
Gender	4023.328	1	4023.328	80.374	.000
Method and Gender	1318.878	1	1318.878	26.347*	.000
Error	11763.542	235	50.058		
Total	1039324.000	240			
Corrected Total	40089.850	239			

*Significant at 0.05 alpha level

3.1. Discussions

From the findings of the study, it was found out that there exist a significant difference between the academic achievement of students taught with games and those taught without games. The result showed that

the experimental group had a higher adjusted mean than the control group. Thus, the use of mathematical games enhances the learning of algebraic expressions than the non-use of games.

The success of the experimental group may be attributed to the anchoring effects that mathematical games have on learning. The nature of mathematical games provide the potential of helping learners to conceptualize mathematics as being transparent and the concepts as being interrelated. This aids information integration and thus provides room for meaningful learning.

The above findings are consistent with the findings of Iji, Abakpa and Takor (2013), Etukudo (2012) and Ebele (2010) that showed significant difference in achievement between the experimental and control groups when the experimental group was exposed to mathematical games [24]-[26].

The finding is however in contrast with that of Nwachukwu (2002) that showed no significant difference between the experimental and control groups when the experimental group was exposed to advance organizer [27]. The significant difference is as a result of the anchoring effects that mathematical games has on learning and the efficacy of mathematical games in incorporating new information. Thus, if the secondary school mathematics teachers adopt appropriate mathematical games in teaching of the subject, students will understand the mathematics concepts taught to them. This is because the difficulty and low popularity index of mathematics is linked with the difficulty in understanding many concepts in mathematics.

The finding of this study also showed a significant difference between the mean achievement scores of male and female students in algebraic expressions. The findings also revealed that the male students had a higher adjusted mean than the female students. This implies that the games favoured the male students than the female ones.

The higher achievement of male students in this study could be due to the fact that mathematics games have led to greater understanding, increase in motivation and development of positive attitude towards the concept of algebraic expressions. The higher achievement of the male students could also be attributed to the fact that as little children, the males love playing games a lot than the females. And this love for games has spurred them to achieve more than their female counterparts in this study. Also, the higher achievement of the male students could be attributed to the fact that they are interested in professions such as Engineering and Architecture which has mathematics inclination.

Contrary to these results, Iji, Abakpa and Takor (2013) obtained no significant difference between male and female students in their study [24]. They observed that both male and female students could do well in algebraic linear graph when exposed to similar learning conditions. Also, Etukudo (2012) found no significant difference between the academic achievement of male and female students after treatment [25]. Ebele (2010) also found that no significant difference exists between male and female students academic achievement in mathematics [26]. Galadima and Okegbenin (2012) also added credence to no significant difference between male and female students academic achievement in mathematics when exposed to the same learning conditions [12].

The findings revealed that the differences in intellectual ability between male and female students can probably be attributed to differences in socialization. Thus, any good teaching strategy like the mathematical games will improve the academic achievement of male students. This is evident by the gain in the mean scores of both sexes, although the gain was higher in the male than the females.

On interaction effect, the findings of the study revealed a significant interaction effect between method and gender. The interaction was however higher in the males than in the females. This was as revealed by the analysis in Table 3 that showed higher adjusted mean in the males than in the females. This is however in contrast with the findings of Ebele (2010), Etukudo (2012) and Iji, Abakpa and Takor (2013) that showed no significant interaction effect between method (teaching methods) and gender [24]-[26].

4. RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

- a. Mathematics teachers at the junior secondary school level should adopt appropriate mathematical games in the teaching of mathematics concepts. This is judged from the facilitating and retentive abilities of mathematical games.
- b. Authors of mathematics textbooks are encouraged to employ mathematical games in writing textbooks. This will make for easy adoption by the mathematics teachers.
- c. Mathematics curriculum at the junior secondary should be reviewed with the aim of incorporating appropriate mathematical games curriculum development stage.
- d. The federal and state governments and other professional bodies like the Nigerian Educational and Research Council (NERDC), Science Teachers Association of Nigeria (STAN), Mathematical Association of Nigeria and the National council for Teachers of Mathematics (NCTM) should sensitize other stakeholders in the education sector on the efficacy of mathematical games.

5. CONCLUSIONS

Based on the findings of this study, the following conclusions were drawn: Mathematical games (Card Games and Algebra Tic-Tacmatics) are effective strategy for meaningful learning to occur in mathematics. The use of games improved better the male students' achievement in algebraic expressions. Thus, for better achievement in algebraic expressions, teachers of mathematics should be encouraged to adopt appropriate mathematical games in conjunction with other appropriately selected teaching methods. The variety of teaching methods will thus help to increase the students' understanding of the subject. In this way, higher achievement could be ensured and the perceived abstract nature of mathematics (algebraic expressions) reduced.

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