EFFECTS OF MATHEMATICAL GAMES ON THE ACADEMIC ACHIEVEMENT OF SENIOR SECONDARY SCHOOL STUDENTS IN MATHEMATICS IN ABUJA, NIGERIA

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ABSTRACT
The consistent poor achievement of students in mathematics at various levels of examinations particularly in West African Senior School Certificate Examinations (WASSCE) and National Examination Council (NECO) is becoming more disturbing to every member of the public and calls for serious concerns and improvement. The study investigated the effects of mathematical games on the academic achievement of senior secondary school students in mathematics in Abaji Council Area of Federal Capital Territory, Abuja. The study adopted quasi-experimental design of pretest-posttest control group. The sample size of one hundred and twenty-three (123) senior secondary one (SS1) students made up of sixty-nine (69) males and fifty-four (54) females, drawn from two selected secondary schools out of five senior secondary schools was used for this study. Tossing of a coin was used to randomly assign intact classes to experimental and control groups. A Pre-AAT was administered before the treatment to establish the students’ level of achievement. The students in the control and experimental groups obtained mean scores of 41.38 and 41.47 respectively. Data were generated using Algebraic Achievement Test (AAT). The instrument was subjected to three experts’ judgment for validation. A logical validity index of 0.85 was obtained. The reliability coefficient of 0.84 was obtained for AAT. The generated data were analyzed using descriptive statistics to answer the research questions and t-test inferential statistics was used to test the null hypotheses at the 0.05 level of significance. The findings revealed that the students taught with the use of game had a greater mean score of 61.12 than their counterpart taught without the use of game with a mean score of 45.38. Also, the results of hypotheses testing revealed that there was a significant difference between the students taught with mathematical game and their counterparts taught without the use of mathematical game since t-cal =5.28 > t-crit=1.96. Female students had higher mean score of 76.25 than the male students with mean score of 58.53. Thus, the hypothesis showed that gender had significant influence on students’ achievement since t-cal =3.57 > t-crit=2.01. Based on the findings, it was recommended among others that teachers should use games to introduce new concepts in engaging students in the teaching and learning of mathematics in the classrooms.

INTRODUCTION

Background to the Study
Mathematics as a subject is very important and useful tool for national development. Nigeria as a nation cannot develop scientifically and technologically if its citizens’ standard of mathematics achievement is not taken care of. For the nation to be among the first twenty countries in world economies in the year 2020, there is need for a good output in mathematics achievement. Mathematics is vital in all aspects of human endeavour. It is an indispensable tool. There cannot be successful development in the nation except the mathematical foundation is given attention.
Most technological developments today in Nigeria owe their origin to scientific discoveries and the bedrock for scientific discoveries is mathematics (Iji, 2008).

Mathematics is an essential and pre-requisite for students’ admission into tertiary institutions for any course of study. Mathematics without doubt remains very important to all disciplines (Odili, 2006). It has continued to play significant roles in the development of both the individuals and the nation. Hence, for the survival and development of the nation, there is a need for the improvement of teaching and learning of mathematics.

Mathematics plays a vital role in educational measurement and evaluation. Thus, mathematics is a necessary tool for effective and qualitative functional education in the national and human developments.

The teaching and learning of mathematics is currently in a challenging stage because of the constant poor achievement of students in both internal and external examination results. For instance, in 2011WAEC report, over 65.01% of Nigerian students failed mathematics in Senior Secondary School Certificate Examination (SSCE). Also, in the years 2012, 2013, 2014, 2015 and 2016 the percentage pass with credit and above were 38.81%, 36.57%, 31.30%, 34.18%, and 38.68% respectively in the same examination (WAEC Examiners’ Reports, 2011-2016). Also, National Examination Council (NECO) report of Senior School Certificate Examination in the years 2014, 2015 and 2016, the percentage pass with credit and above were 52.29.0%, 69.49% and 65.50% respectively (NECO Examiners’ Reports, 2014-2016). Despite its importance, it is the subject students viewed as being the most difficult to understand and pass (Imoko & Agwagah, 2014). Students cannot achieve excellent results except the best methods of teaching and learning of mathematics are discovered and used appropriately. The abstract nature of mathematics as a subject scares many students. Mathematics could be related to real life situations and taught practically to bring changes in the negative perception of the subject as being difficult. Musa and Agwagah (2006) in support of practical approach opined that practical activities enable learners to acquire the relative experience that links learning to environment on their own through the process of thinking, thereby causing positive changes in their activities.

In Nigerian, people like playing games for fun and excitement, which tend to reduce tension, anxiety and fear. Such friendly atmosphere creates co-operation, collaboration, attention and interest. Hence, in order to overcome the mathematics phobia in students, the use of games in the teaching and learning of mathematics in the classroom is most likely to induce improved learning. Such games are referred to as mathematical games.

Mathematical games can be described as those practical activities which bring about fun, excitement and challenges between two or more contestants and at the same time enhance learning of mathematics. It can help in maintaining and sustaining interest in students, thus leading to good academic results (National Mathematical Centre, 2002). Odili (2006) says that games in general serve the purpose of recreation and often generate excitement and the spirit of competition. Games serve as reinforcement to both winners (to strive to maintain their lead) and losers (to strive to overcome their defeat).

The National Mathematical Centre (2002) lamented that one of the roles of mathematical games is to develop positive attitude towards mathematics. The informality and excitement of games can lead to the development of positive attitudes. Students tend to like activities that excite them. The Mathematical games have repeatedly been proven to increase students understanding and achievement in mathematics in Washington, D.C. (Ortiz, 2003). Wetsh, Russel, Williams, Reisner
and White (2002) reported that in New York City, opportunities to engage in mathematical games and teaching gives students the practice, application and special help needed to achieve higher levels of performance. Thus the use of games in the teaching and learning of mathematics is aimed to bring an improvement the academic achievement of students in mathematics. Therefore, this study assessed the effects of mathematical games on academic achievement of senior secondary school students in mathematics in Abaji Council Area of Federal Capital Territory, Abuja.

Purpose of the Study
The main purpose of the study was to investigate the effects of mathematical games on academic achievement of senior secondary school students in mathematics. The specific objectives were to:

1. find out the effect of the use of mathematical game on students’ achievement in mathematics.
2. determine the influence of gender on students’ achievement in mathematics when mathematical game is used in teaching and learning.

Significance of the Study

Findings from the study on the effects of mathematical games on academic achievement of Senior Secondary School Students in mathematics may contribute significantly to the improvement in the teaching and learning of mathematics in schools. Teachers may discover new strategies of assessing students and diagnosing a wide variety of their mathematical strengths and weaknesses once they are engaged in playing games. Also, teachers might find games as motivating factor for students who are slow learners and below average in their achievement. The teaching and learning of mathematics should be more of students-centred than teacher-centred since students are actively and practically engaged in the learning of mathematics. Students who have phobia for mathematics will benefit from this study since the use of games might provide opportunities for building self-concept and developing positive attitudes towards mathematics, through reducing fear of failure. Thus, more students might develop interest in studying mathematics at tertiary institutions.

Government may appreciate and use the findings from this study for positive improvement and implementation of the general objectives for mathematics education as drawn up by the Federal Republic of Nigeria (FRN). Various schools might be motivated to provide mathematical games for the teaching and learning of mathematics in the classrooms.

Curriculum Planners may use the relevance of the findings from this study and the need of incorporating the use of games in the school. Finally, parents may use the outcome of this study to provide games that will engage their children in mathematics at home since this may provide opportunities to monitor, advise and encourage their children towards positive achievement in mathematics.

Research Questions

The following research questions were answered in the course of this study:
1. what is the effect of mathematical game on the students’ academic achievement in mathematics?
2. what is the influence of gender on students’ achievement when taught mathematics with the use of mathematical game?

Hypotheses

The following hypotheses were formulated and tested at .05 level of significance.

1. There is no significant difference between the achievement of students taught with the use of mathematical game and that of their counterparts taught mathematics without the use of mathematical game.
2. Influence of gender is not significant on students’ achievement when taught mathematics with mathematical game.

METHODOLOGY

Research Design

The research design adopted for this study was quasi-experimental design of pretest – posttest control group. The choice of this design was made as none of the true experimental designs were possible. This design was used because the researcher was interested in studying the cause and effect and in manipulating the independent variable (game) in order to observe its effect on the dependent variable (academic achievement).

Population

The target population of this study was senior secondary school one (SS1) students in Abaji Council Area of Federal Capital Territory (FCT), Abuja. The study population was one hundred and twenty-three (123). The study targeted the five (5) senior secondary school one (SS1) students in Abaji Council Area with a population of one thousand and eighty six (1,086) students that consisted of five hundred and sixty five (565) male and five hundred and twenty one (521) female students.

Sample and Sampling Technique

The sample of the study was drawn from senior secondary school one (SS1) students since it is the foundation class for senior secondary schools. The total sample size comprised one hundred and twenty-three (123) students, made up of sixty nine (69) males and fifty four (54) females.

In each of the selected schools, tossing of a coin was used to randomly assign intact classes to experimental and control groups. The experimental group had 34 male and 24 female students while the control group had 35 male and 30 female students.

Instrumentation

The instrument used for data collection was the researcher designed questionnaire titled “Algebraic Achievement Test” (AAT). The AAT consisted of 20-items based on SS1 mathematics scheme of work. The topic covered was algebraic processes. The game used for the study was “Algebraic Substitution Game”. This is a mathematical game that is used for substituting numbers into algebraic expressions.
The items of AAT were developed using lower and higher order questions. The lower order questions covered knowledge and comprehension, while the questions involving higher thinking processes covered application and analysis of cognitive domain. Two lesson notes were prepared based on some selected sub-topics on algebraic processes and used for teaching the students in experimental and control groups. The specific objectives to be achieved by the end of the lessons were clearly stated. Evaluation was carried out at end of the lessons.

Validation and Reliability of the Research Instrument

The face and content validity of the instrument (AAT) was critically appraised by three experts. The outcome of the appraisal of the items based on the experts’ judgment gave 0.85 index of logical validity.

The validated instrument (AAT) was trial tested to determine the reliability of the instruments using 24 students who were part of the target population of the study but did not form part of the study. Split-half reliability method was used to establish the internal consistency (reliability) of the instrument. The reliability coefficient of 0.84 was obtained.

AAT constructed by the researcher was subjected to test of psychometric properties (Item Analysis). Some of the items in AAT were corrected and modified. The instrument was considered to be adequate with an average of 0.56 as difficulty index, 0.63 for discrimination average index and -0.13 as distracter average index for the items.

Administration

The researcher sought the permission of the principals of the two selected schools to allow their schools to be used for the study. The researcher trained two research assistants for one week. These two research assistants were regular classroom teachers of mathematics. The overview on the algebraic processes and the procedures on the use of the Algebraic substitution game was explained and taught by the researcher. The students were taught by the research assistants who had been trained by the researcher for one week before the commencement of the experiment. The teaching lasted for two (2) weeks. With the help of the research assistants, PreAAT was administered before the treatment to ascertain the level of students’ achievement in algebraic processes. Students in the experimental group were taught by one of the research assistant using game while game was not used by the other research assistant to teach students in the control group. The Post-AAT was administered after the treatment to find out the effect of game used on students’ achievement.

The rules and mechanics of the game were explained to the students after which they competed against one another. The Post-AAT answered by the students in both groups were marked and scored using the marking scheme.

The researcher supervised all the two (2) schools to ensure uniformity in instructions and administration of the instruments by the research assistants. The researcher adopted the following procedures to ensure that extraneous variables which may introduce bias into the study were controlled.

In order to control teacher variable the researcher organized a uniform training program for the teachers who served as research assistants in the study. Different sessions were organized for the experimental and control groups. The same research assistants were involved in handling experimental and control groups. The lesson notes were prepared by the researcher and made
available for the teachers’ use in order to establish a common teaching standard among them. The researcher was the custodian of the test instruments until they were needed and demanded by the teachers. The researcher played a supervisory role to prevent the teachers from deviating from the normal content of the lesson plans.

The Pre-AAT instrument used by the teachers and students were retrieved by the researcher to prevent students using them. Also, Hawthorn’s effect which refers to the fact that behaviours may be altered when students know that they are being studied for experiment was put under control.

Data Analysis and Results

The data collected were analyzed using mean and standard deviation to answer the research questions raised and t-test statistical tool was applied to test the formulated null hypotheses (HO) at p≤0.05

Comparison of the Pretest - Posttest Mean Scores of the Experimental and Control Groups

Post-AAT was administered on the students in both experimental and control groups after the treatment to find the difference between Pre-AAT and Post-AAT mean scores

Table 1: Mean Gain Scores of students’ achievement in mathematics for Experimental and Control Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Mean Gain Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>58</td>
<td>41.47</td>
<td>61.12</td>
<td>19.65</td>
</tr>
<tr>
<td>Control</td>
<td>65</td>
<td>41.38</td>
<td>45.38</td>
<td>4.00</td>
</tr>
</tbody>
</table>

Table 1 shows the mean scores of 41.47 and 41.38 for the experimental and control groups respectively for the pretest, and 61.12 and 45.38 for the posttest. The mean gain for the experimental group was 19.65 while that of the control group was 4.00. This showed that the experimental group had higher gain score than the control group.

Research Question1: What is the effect of mathematical game on students’ academic achievement in mathematics?

Table 2: Descriptive statistics of students’ academic achievement for experimental and control groups

<table>
<thead>
<tr>
<th>Group</th>
<th>X</th>
<th>S.D</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>61.12</td>
<td>15.03</td>
<td>58</td>
</tr>
</tbody>
</table>
Table 2 shows the mean scores of 61.12 and 45.38 for both experimental and control groups respectively. This showed that the mathematical game had an effect on students in the experimental group who had higher mean achievement score than their counterparts in the control group who were taught without the use of game. Thus, the use of mathematical game had an effect on students in the experimental group.

Research Question 2: What is the influence of gender on students’ achievement when taught mathematics using mathematical game?

Post-AAT was administered on both male and female students when taught with game, and the raw scores were collected and analyzed.

Table 3: Descriptive statistics on the influence of gender on students’ achievement when taught with mathematical game.

<table>
<thead>
<tr>
<th>Group</th>
<th>X</th>
<th>S.D</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>58.53</td>
<td>14.83</td>
<td>34</td>
</tr>
<tr>
<td>Female</td>
<td>76.25</td>
<td>20.90</td>
<td>24</td>
</tr>
</tbody>
</table>

The statistics showed that the female students had higher mean achievement score of 76.25 than the male students with the mean achievement score of 58.53 when taught mathematics using mathematical game. Thus the female students performed better than the male students.

Hypothesis 1

H0: There is no significant difference between the achievement of students taught with mathematical game and their counterparts taught without the use of game.

Table 4: t-test on the post-test mean achievement scores between the experimental and control groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>X</th>
<th>S.D</th>
<th>N</th>
<th>df</th>
<th>S.E</th>
<th>t-cal</th>
<th>t-crit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>61.12</td>
<td>15.03</td>
<td>58</td>
<td>121</td>
<td>2.99</td>
<td>5.28</td>
<td>1.96</td>
</tr>
<tr>
<td>Control</td>
<td>45.38</td>
<td>18.13</td>
<td>65</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4 reveals that at $p \leq 0.05$, the $t_{cal} = 5.28 > t_{crit} = 1.96$. Therefore, the null hypothesis ($H_{O1}$) was rejected. Thus, students taught with the use of mathematical game achieved significantly higher than their counterparts taught without the use of game.

Hypothesis 2

$H_{O2}$: Influence of gender is not significant on students’ achievement when taught mathematics with mathematical game.

Table 5: $t$-test on the post-test achievement scores between male and female students taught with mathematical game.

<table>
<thead>
<tr>
<th>Group</th>
<th>$\bar{X}$</th>
<th>S.D</th>
<th>N</th>
<th>df</th>
<th>S.E</th>
<th>t-cal</th>
<th>t-crit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>58.53</td>
<td>14.83</td>
<td>34</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.97</td>
<td>3.57</td>
<td>2.01</td>
</tr>
<tr>
<td>Female</td>
<td>76.25</td>
<td>20.90</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the table, the $t_{cal} = 3.57 > t_{crit} = 2.01$. Therefore, the null hypothesis ($H_{O2}$) was rejected. Thus, female students achieved significantly higher than their male counterparts when taught mathematics with mathematical game.

Summary of Findings

The findings from the data analysis on the study of the effects of mathematical games on the academic achievement of senior secondary school students are stated as follows:

The students in the experimental group had greater mean score than their counterparts in the control group. Also, the $t$-test showed that there was a significant difference between the achievement of students taught with the use of mathematical game and their counterpart taught without the use of mathematical game.

The female students had greater mean achievement scores than their male counterparts. However, the tested hypothesis 2 revealed that gender had significant influence on students’ achievement when taught mathematics with the use of mathematical game.

Discussion

Based on the findings, the following discussions were made:

The students in the experimental group who were taught mathematics with the use of mathematical game had greater achievement score that their counterparts in the control group who were taught without the use of mathematical game. This finding revealed that the mathematical game was effective than the conventional method (without the use of game) as regards the academic achievement. The findings of this study revealed that there was significant difference between the achievements of students taught with the use of mathematical game compared to their counterparts taught without the use of mathematical game. The result of this study, therefore is in agreement with the previous research findings of Galadima and Okogbeni (2012) in Nigeria and Mustafa, Khan and Ullah (2011) in Pakistan that there was significant difference in the
performance of the students who were taught with the use of mathematical game compared to their counterparts who were taught without the use of mathematical game.

Secondly, the result showed that the female students mean achievement score was greater than that of the male students mean achievement score when taught with the use of mathematical game. Thus, gender had significant influence on students’ achievement when taught mathematics with game method. The finding was in conflict with Galadima and Okogbenin (2012), and Achor, Imoko and Ajai who confirmed that gender had no significant influence on students’ achievement when game was used. Hence, this showed that mathematical game enhanced the mean achievement of female more than male students. However, this finding was in confirmation with that of Etukudo (2002) who found great significant performance in mathematics for both male and female students when Computer Assisted Instruction (CAI) was used.

Conclusions

The results of this study showed significant difference between the achievements of students taught with the use of mathematical game compared to their counterparts taught without the use of mathematical game. Also, gender had significant influence on students’ achievement when taught mathematics with the use of game. It can be concluded that the use of mathematical game is effective in students’ academic achievement in mathematics.

Recommendations

Based on the findings from the study, the following recommendations were made:

1. the use of mathematical games that can enhance the teaching and learning of mathematics should be encouraged and used by teachers to introduce concepts in mathematics to all students at different levels.
2. to create friendly atmosphere of student-centered teaching and learning, mathematical games should be used by teachers to engage students in the learning of mathematics concepts.
3. regular training workshops and seminars should be organized for mathematics teachers to improve their knowledge of using mathematical games in the classrooms.
4. simple local games like ayo, ludo, whot and playing cards which facilitate the teaching and learning of specific topics in mathematics should be provided by the school administrators for teachers’ use.

REFERENCES


West African Examinations Council (waec may/june). *Chief Examiners’ Reports* (20112016).Yaba, Lagos.