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Effect of Game- Based Instructional Model on the Pupils Achievement in Arithmetic at Upper Primary Schools Level in Igbo – Etiti Local Government Area, Enugu State, Nigeria

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Abstract
The study investigated the effect of game-based instructional model approach on the pupil's achievement in Arithmetic. The research design used in this study was pre-test-post-test, control quasi experiment design. Sample random sampling technique was adopted in selecting 203 primary five pupils from 6 intact classes in six randomly selected primary schools in Igbo-Etiti local government area, Enugu State, Nigeria. A research instrument called Arithmetic Achievement Test (AAT) developed and validated by the researcher was used in data collection. The study was guided by two research questions and two hypotheses. The hypotheses were tested at 0.05 level of significance. The result of the finding showed that there was a significance difference in achievement in Mathematics of pupils exposed to game-based instructional model approach and those exposed to conventional method. There was mean difference in mathematics achievement between male and female pupils. This mean difference was tested and found significant at $p \leq .05$. Based on the findings, the game-based instructional model approach was recommended to the teachers, curriculum workers as well as examination bodies to popularize its effective integration into the mathematics classrooms.
Keywords: Mathematics, game-based instruction, and Arithmetic

Introduction

The nation's Millennium Development Goals (MDGs) is being specifically addressed by the National Economic Empowerment and Development Strategy (NEEDS) which is Nigeria's plan for prosperity with ultimate intension of improving economic well – being, social and human development and ensure environmental sustainability and regeneration. In other words one of the major objectives of NEEDS' is to actualize the MDGs goals of making Nigeria a wealthy nation by 2015 through poverty reduction (NEEDS, 1999). This objective can be achieved if Nigeria's nation promotes science and technology through concerted effort in teaching and learning of the 'queen' and 'language' of science and technology called mathematics. Really, science and technology creates wealth, and mathematics is a categorical imperative for any nation with a focused scientific and technological aspiration (Ale and Adetula, 2010).

According to Adetula (1989), outstanding mathematical ability is a precious societal resource sorely needed to maintain leadership in a scientific and technological world. Obviously, mathematics is a special cognitive tool that is indisputably acknowledged as agent of nation's development and wealth creation. According to Ale and Adetula (2010), the knowledge of mathematics will help Nigeria to produce citizens that can manufacture drugs, raw materials, machines and tools needed for our industries. More so, it will help us to produce enough food for local use and exportation. Basically, an important component needed to achieve all these is the enhanced teaching and learning of mathematics, science and technology education in formative levels of primary and post – primary as well as at the tertiary level of education.

There is doubt that NEEDS will achieve the noble MDGs objective by 2015, following incessant reports on students' poor performance in mathematics over the years. For instance, NECO (2009) reported that over 92.8% of students who took the Senior Secondary Certificate Examination (SSCE) in 2009 could not obtain the minimum qualification for entry into tertiary institutions. According to Eniayeju and Azuka (2010), one major cause for this unfortunate situation was the poor performance in mathematics. More so, over the years, there has been a repetition of poor performance and failure of students in mathematics at Secondary School level (Olaleye, 2004). Again, Usman and Nwoye (2010), reported that students are still performing poorly in mathematics. The reports on students' poor performance in mathematics suggest that students have poor mathematics foundation right from primary school level. If the present trends continue unabated, the country is not likely to meet the millennium Development goals (NEEDS,).

Researchers in mathematics education have reported some of the causes of the poor performance in mathematics among Secondary School Students. For instance, (Okonkwo, 1998, in Unodiaku, 2010; Obienyem, 1998, in Unodiaku, 2010; and Ogbuanya, 2009) attributed students' poor performance in mathematics to lack of readiness or preparedness of primary school pupils for further learning of mathematics at Secondary School level. On similar note, Unodiaku (2011) reported that readiness to learn mathematics is a factor that enhances achievement in mathematics learning. More so, poor assessment of mathematics process skills of students

learning outcome due to scarcity of developed valid and reliable instruments, contributes significantly to Students' poor achievement in mathematics (Unodiaku, 2011). According to Igwebuike (1985) in Ogbuanya (2009), lack of adequate or sound background in lower classes is one of the problems that kill children's interest in mathematics; and most teachers use wrong methods in presenting mathematics and in handling the children. Similarly, Agwagah (2001) in Usman and Nwoye (2010) reported that mathematics teaching and learning should involve games, in order to arouse the interest of pupils in mathematics which will be helpful in achieving a better performance in mathematics. The researcher believed that another way to create and sustain students' interest permanently in mathematics is by teaching mathematics with varieties of methods, instructional materials and techniques, especially games. This apart from making mathematics learning more interesting, it will tend to improve students' achievement in mathematics.

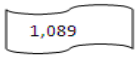
Furthermore, Kay (1971) in Ogbuanya (2009) reported that poor foundation for acquiring mathematics knowledge in the infant classes is one of the causes of poor performance in mathematics. According to Kay (1971) in Ogbuanya (2009), the right foundation should be laid right from the infant classes and therefore it is vital that the teaching of numbers should be on the right lines from the very start of formal education, because failure to acquire this fundamental background at the early stages would eventually lead to backwardness in mathematics. It is against this background that the researcher intend to use game to teach children arithmetic. Specifically, the game called subtraction and addition game (SUBADIG) are aimed at arousing the interest of pupils in addition and subtraction of whole numbers and in enhancing mathematics learning generally. The game was guided by certain rules and was played between the teacher (who acts as a moderator) and the students who solve the mathematics problem(s) given by the teacher. The game is organized under two phases. The first phase deals with addition and subtraction of three digit numbers while the second phase deals with addition and subtraction of four digit numbers. The game was guided by certain rules.

The rules of the SUBADIG for Addition and Subtraction of three digit whole numbers.

1. The first and last digits should not be consecutive numbers i.e. for a game of three digits numbers such as 726, 382, 594 or 918 should not be chosen because 7 and 6 are consecutive numbers in the number 726.
   More so, for the second number 382, 3 and 2 are consecutive numbers. Choose numbers like 947, 264, 518, 410, and so on.
2. Number of players ranges from two persons and more ideally the games can be played between a teacher and his student(s). or between a parent and his child (children), among other categories of individuals.
3. The games are limited to primary 3 or 4 pupils who have just completed learning addition and subtraction of whole numbers but might not have mastered or internalized the skills of addition and subtraction of whole numbers.
4. Each of the digits of the three-digit numbers to be chosen must be different (i.e. no identical digits). That is there must not be 484 or 779 or 666, and so on.

INSTRUCTIONAL MODEL: EXAMPLE 1: **Illustration/procedure of the SUBADIG using three digits numbers.**

The procedure of the game is organized using the following steps.

Step 1: Without letting the pupil look, the teacher wrote 1,089 on a sheet of paper like this 

and folded it. The teacher put the folded paper into the child's pocket (without the child knowing the figure inside it).
Step 2: The teacher told the pupils to choose any three digit number provided the three digits are different and the first and last digits are not consecutive numbers. A pupil chose 589.
Step 3: The teacher told the pupil to reverse the new number on his sheet of paper. The reverse order is such that 589 become 985.
Step 4: The teacher instructed the child to subtract the smaller number (589) from the larger number (985). i.e.

$$\begin{array}{rrr} 9 & 8 & 5 \\ - & 5 & 8 & 9 \\ \hline & 3 & 9 & 6 \end{array}$$

Step 5: The teacher instructed the child to interchange the last and first digits of the result (396) to get 693.
Step 6: The teacher told the child to add the result (396) to the new number (693) to get

$$\begin{array}{rrrr} 3 & 9 & 6 & \\ + & 6 & 9 & 3 \\ \hline & 1,0 & 8 & 9 \\ \hline \end{array}$$

Step 7: The teacher now told the child to bring out the folded paper inside his pocket only to discover that the number in the paper and the result of the above SUBADIG are the same i.e. 1,089.

EXAMPLE 2 Illustration/Procedure Of SUBADIG Using Four-Digits Numbers.

In this case, the teacher played the game with all his class members of 43 pupils.

Step 1: The teacher first drew the attention of the pupils to the rules of the game. The teacher instructed one of the pupils to tear out a clean sheet of paper and pass it round to others to certify that the paper is blank.

Step 2: When the paper was returned to the teacher, he secretly wrote the number 6,174 on the sheet of paper, folded it and placed it on a desk that is conspicuously positioned for every class member to see and out of reach to anybody.

Step 3 The teacher instructed them to pick any addition to other rules stated above. One of the pupil's John by name picked wrote down four digit numbers of their choices.

Step 4: The teacher told them to interchange the first and last digits so as to make the largest possible number. John's number which was originally 2579 becomes 9572 and Mary's number which was originally 4618 becomes 8614.

Step 5: The teacher instructed them again to interchange the last and first digits to make the smallest possible number. That is John's number 9572 becomes 2579 and Mary's 8614 becomes 4618.

Step 6: The teacher told them to subtract the smaller number from the bigger. That is John's new number becomes 9572-2579=6993 and Mary's new number becomes 8614 – 4618 = 3996.

Step 7: The teacher instructed them to interchange the first and last digits of their new numbers. Therefore, John's number 6993 becomes 3996 and Mary's number 3996 becomes 6993.

Step 8: The teacher finally instructed them to add their last two numbers.
John's number becomes 3996+6993=10,989 and Mary's numbers
3996+6993=10,989. Similar results were obtained by all the class members that chose different numbers.

Pupils' loss of interest and backwardness in mathematics in later years were due to failure to lay solid foundation right from the infant classes, rote learning and poor teaching methods. Therefore, mathematics teaching and learning should involve games in order to arouse the interest of pupils in mathematics which will be helpful to achieve a better performance in mathematics (Agwagan, 2001, and Igwebuike, 1985, in Ogbuanya, 2009.)

Hence, the study was design to investigate the effect of a Game-based instructional model on pupils' achievement in Arithmetic problem solving.

Purpose of the Study

The main purpose of the study was to find out the effect of game-based instructional model approach on the primary schools pupils' achievement in arithmetic learning. Specifically the study tried to determine:

- The effect of game-based instructional model approach on the mean achievement scores of pupils in arithmetic learning.
- Effect of gender on game-based instructional model mean achievement scores in arithmetic.

Research Questions

The following research questions guided the study:

1. What is the difference between the mean achievement scores of pupils taught arithmetic with game-based instructional model and those taught with conventional method?
2. To what extent does gender influence the mean achievement scores of the pupils taught arithmetic using game-based instructional model approach?

Research Hypotheses

1. There is no significant difference between the mean achievement scores of pupils taught arithmetic with game-based instructional model approach and those taught with conventional method.
2. There is no significance difference between the mean achievement score of male and female pupils taught arithmetic with game-based instructional model approach.

Research Method

The design of the study was quasi-experimental research design. Specifically, it is pretest-posttest non-equivalent control group design. The study was carried out in Igbo-Etiti Local Government Area of Enugu State. The population of the study consisted of 2908 primary five pupils in the 66 primary schools in Igbo-Etiti Local

Government Area of Enugu State. The sample for the study was 203 primary five pupils obtained from six intact classes in six randomly selected schools from 66 primary schools in the Igbo-Etiti Local Government Area. Three of the six selected schools were randomly assigned into experimental groups, made up of 106 pupils, while the remaining three were assigned to control group, composed of 97 pupils.

The instrument used for data collection was called Arithmetic Achievements Test (AAT). The instrument was composed of two sections viz: A and B. Section A contains 5 items treating three-digit numbers while section B contains 5 items treating four-digit numbers. In totality, the instrument contains 10 items used for the study. The instrument was validated by experts and its reliability coefficient was determined using Cronbach alpha procedure. The reliability coefficient yielded 0.83.Mean and Standard deviations were used in answering the research questions posed while research hypotheses were tested using the analysis of covariance (ANCOVA) at $p \leq 0.05$. The pretest scores were used as covariance to the posttest scores.

Results

The results are presented in accordance with the research questions and hypotheses.

Research question 1: What is the difference between the mean achievement scores of pupils taught arithmetic with game-based instructional model approach and those taught with conventional approach?

Table 1: Mean and Standard deviation of pupils' achievement scores of subjects on Arithmetic Test.

Group	Pre-test		Post -test		Mean Difference within the Group.
	Mean	Standard Deviations	Mean	Standard Deviations	
Experiment (n=106)	5.40	1.021	7.83	.593	2.43
Control (n=97)	3.67	.875	4.24	.922	1.86
Mean difference between the group	1.73		3.59		

Table 1 showed the results of the AAT administered on pupils. From the table, it was observed that in the pre-test, experimental group taught with game-based instructional model approach had a mean of 5.40 with a standard deviation 1.021, while the control group taught with conventional approach had a mean of 3.67 and standard deviation of .875. Similarly, in the post-test, experimental group had a mean of 7.83 with a standard deviation .593 while the control group taught with conventional approach had a mean of 4.24 with a standard deviation of .922. The mean difference between the groups is 1.73. However, the difference within the group for the experimental is 2.43 while the difference within the group for the control is 1.86. Therefore there was a great difference in the mean achievement of pupils taught arithmetic using game-based instructional model approach, and those taught using conventional approach. This clearly implied that game-based instructional model approach method is more effective.

Research Question 2: To what extent does gender influence the mean achievement scores of the pupils taught arithmetic using game-based instructional model approach?

Table 2: Mean Achievement Scores and Standard Deviation of Males and Females in Arithmetic Test.

Sex	Mean ($\bar{x}$)	Standard Mean
Male (n=89)	5.73	1.857
Female (n=114)	6.41	1.986
Difference in mean	0.68	

Table 2 showed the achievement scores of pupils on AAT. The male pupils taught arithmetic using game-based instructional model approach had a mean of 5.73 with the standard deviation of 1.853 while their female counterpart had a mean score of 6.41 with standard deviation of 1.986. The mean difference between male pupils' and female pupils' scores is 0.68.

Hypothesis 1 and 2 were answered using Table 3 below

Table 3: Analysis of covariance for Hypothesis 1 and 2 on pupils achievement in Arithmetic Test.

Source	Type III sum of squares	df	Mean square	F	Sig.
Connected model	670.989	4	167.747	327.537	.000
Intercept	268.795	1	268.795	524.838	.000
Protest	.012	1	.012	.023	.879
Group	324.400	1	324.400	633.412	.000
Gender	14.039	1	14.039	27.411	.000
Group & gender	.483	1	.483	.943	.333
Error	101.405	198	.512		
Total	8359.000	203			
Corrected Total	772.394	202			

Table 3 showed the ANCOVA results of pupils who were taught Arithmetic with game – based instructional model approach and conventional approach. In the table, group has F value of 633.412 and significant at .000. This significant value (.000) is less than .05 (i.e. .000 ≤ P ≤ .05). Therefore, F is significant at .05. Hence the hypothesis is not accepted. That is, there is significant difference between the mean achievement scores of pupils taught Arithmetic with game–based instructional model approach and those taught with convectional method. More so, gender has F value of 27.411 and significant at .000. This significant value (.000) is less than .05 (i.e. .000 ≤P≤ .05). Therefore, F is significant at .05. Hence, the hypothesis is not accepted. That is, there is significant difference between the mean achievement scores of male and female pupils taught Arithmetic with game–based instructional model approach.

Discussion

Reversing the trend of poor performance in mathematics requires enhancing mathematics teaching and learning through practical oriented approaches. Invariably game – based instructional model approach belongs to such approaches. For instance, this study clearly indicated that the pupils taught with game–based instructional approach had higher mean gain score than their counterpart taught using the conventional method. This mean difference in performance between those taught with game – based instructional approach and those taught with conventional method was found significant (P < .05). However, the game–based instructional model approach favour females more than males as the result yield mean difference of 0.68 in favour of the female pupils. This mean difference (0.68) between males and females pupils was tested and found significant (P≤.05). It was also observed that game–based instructional model approach motivated, aroused the interest of the pupils as well as increased their participation in Arithmetic learning.

Conclusion

Based on the findings of this study, it was concluded that the game–based instructional model approach is effective in teaching addition and subtraction aspects of Arithmetic. The mean difference in achievement of male and female pupils was found to be in favour of the females. More so, the females performed significantly higher than their male counterparts in the test. This result suggests the need for establishment of differential norms for both male and female pupils. If these factors are taken cognizance of in primary school mathematics pedagogy, there is tendency that fundamental problems in mathematics learning will be permanently resolved.

Recommendations

The following recommendations are made based on the findings of this study.

- Primary school teachers should be sensitized in the use of game–based instructional model, which is interest oriented, in teaching pupils arithmetic. Such sensitization can be actualized through organized work-shops, seminars and conferences for primary school teachers by government agencies such as ministry of education; professional bodies such as Mathematics Association of Nigeria (MAN), Science Teachers Association of Nigeria (STAN). When work-shops, seminars and conferences are organized for and attended by the primary school teachers there is tendency of their learning new approaches in mathematics pedagogy.
- Primary schools mathematics curriculum designers as well as authors of primary schools mathematics textbooks should include game – based instructional model as instructional method.
- Examination bodies such as WAEC and NECO should include questions based on mathematics games on assessment of their candidates. More so, ministry of Education should include questions based on mathematics games on assessment of primary six pupils and Junior Secondary School Certificate Examination candidates.

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