EFFECTOFMATHEMATICSCOMPUTER DIGITAL GAME ON PUPILS' ACHIEVEMENT INMATHEMATICS.

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Abstract.
The study examined the effect of Mathematics Computer Digital Games (MCDG) and conventional teaching strategies on mathematics achievement in Primary Schools in Abuja Municipal Area Council (AMAC), Federal Capital Territory (FCT). Three purposes, research questions and hypotheses guided the study. Quasi-experimental research design was used for the study. The sample size for the study consists of 145 (68 males and 77 females) drawn from six intact classes in AMAC. Purposive sampling technique was used to draw ten public primary schools from AMAC. Simple random sampling was used to draw six intact classes from the ten public primary schools in the area of the study. Mathematics Achievement Test (MAT) was the instrument used for data collection. Kuder-Rechards on formula 20 (K-R 20) was used to determine the reliability of (MAT), which yielded a reliability estimate of 0.83. Mean and standard deviations were used to answer all the research questions and Analysis of Covariance (ANCOVA) for testing the hypotheses. Findings of the study revealed that the use of Mathematics Computer Digital Games (MCDG) in teaching mathematics in primary school improved pupils' achievement in mathematics more than the conventional teaching strategy. The effect of MCDG was in favour of the girls more than the boys. The interaction effect between gender and MCDG was not significant. Some recommendations were made based on the findings of the study.

Keywords: Mathematics Computer Digital Games, conventional learning Strategies, achievement, mathematics

Introduction

Globally, most societies and their education systems are rapidly changing towards Digital Technologies in combination with the study of mathematics. Digital technology is the branch of scientific knowledge that handles the creation and practical use of computerized devices, systems and methods (Radhika, 2018). It involves all forms of electronic equipments that use information in the form of numeric code. Developed nations would not have been where they are today without mathematics. Mathematics is one of the science subjects which provide services to all disciplines, including digital technologies, industrial functions, academic researches, banking, engineering and the economy (Ganbari, Olumorin, & Yusuf, 2013).In Nigeria, mathematics is one of the compulsory subjects in secondary schools and a credit pass in the subject is required for admission into Nigerian higher institutions. Unfortunately, fear, anxiety, lack of interest and conventional teaching methods are associated with low mathematics achievement among pupils in primary schools (Azuma & Awogbeni, 2012).

Conventional teaching method is a method that is practically used by most teachers in Nigeria to impart knowledge to learners. It is basically a teacher-centered teaching technique that pays little or no attention to the learners because teacher's intention is to cover the scheme of work, whether the learners understand the subject or not. This type of teaching strategy requires little or no critical thinking. It makes provision for limited information, because as long as there are no adequate interactions between teacher and learners, knowledge or experiences are not appropriately shared within them. Conventional strategy is an instructive process because the teacher gives all the information required. For Ruiz, Mintzer, and Leipzig (2006), in conventional method, the learners are extrinsically motivated by the desire to get good grades, please the teacher and to acquire rewards. It is basically pencil- and paper representation. This implies that individual differences in learning are not considered at all. It is assumes that all learners learn within the same capacity. Ruiz, et al(2006) also revealed that electronic learning technology provided more valuable opportunities for medical students, when compared to traditional didactic lecture method. This electronic learning technique is a type of computer digital game learning.

Computer Digital Game is any game played with the help of electronics device which could be done online or offline. It has to do with the interaction with an electronic system or computer. Therefore, computer digital games are designed for playing with the computer, video games, and mobile devices (Ott & Pozzi, 2012).Computer Digital Game is a computer game that involves software program in which one or more players make decision by

controlling the game, objects and resources, in the pursuit of its objective (Erhel & Jamet,2013). Azuma and Awogbeni (2012) viewed digital computer game as an enjoyable social activity with goals, rules, and objectives. Li (2012) carried out a study on digital game designers and the result indicated that skills are enhanced when students engage in digital game play and digital game- creation.

Erhel and Jamet's(2013), finding indicated that digital game learning induced less efficient information processing strategies than conventional learning instruction. Another study showed that the application of CDROM software in practical pathology were significantly higher than the group in conventional method (Hosseini, Aghbali, Emamverdizadeh, Hasani& Razbani, 2014).For Ezeugwu, Onuora, Asogwa and Ukoha (2016) the application of game-based instructional technique reactivates students' interest in algebra. In a different study carried out by Aremu and Adebagbo (2016) whenever games are appropriately applied, they have significant effect on mathematics learning and retention. Another study revealed a higher score in mathematics with virtual learning method as against conventional learning method. (Moazami, Bahrampour, Azar, & Jahedi,2014). The poor achievement in mathematics has become a thing of concern as conventional method may be responsible for the low mathematics achievement recorded in primary schools, especially in Abuja, the Nigerian Federal Capital Territory (FCT).

Despite the value attached to mathematics in Nigeria, including the FCT, a high percentage of learners have developed negative interest and attitude towards the subject and this disposition is reflected in the poor mathematics achievement in both internal and external examinations. A review of mathematics achievement across private and public primary schools in Abuja Municipal Area Council (AMAC) revealed high rate of low achievement as recorded below average scores in mathematics. This tends to suggest that the method of instruction adopted by teachers in public and private schools may be a contributing factor to the level of mathematics achievement in schools.

Mathematics is a science that seeks for meaning of numbers in relation to alphabets as it tries to solve real life problems through its application. Abonyi, Maduagwuna and Ugama (2014) define mathematics as a science that seeks to provide the meaning of numbers and use of numbers in solving real life problems. Mathematics, with its abstract quality, may require instructional strategies that are activity based which will fully involve the participation of pupils in the classrooms. According to Khakis and Wafa (2013) mathematics is an abstract science, which, when educational methods and aids are applied, becomes a likeable subject for students. Involving the pupils in the preparation

and implementation of learning activities can make learning interesting. Innovative teaching strategies that are activity- based could have the capacity to enhance academic achievements in classrooms. Computer Digital Games (CDG) is one of the innovative strategies that are used in teaching.

Mathematics Computer Digital Game (MCDG) is an instructional game that is designed to serve as a tool that teachers use to teach different topics in mathematics and other subjects in schools. Khahis and Wafa (2013) described mathematics game as suitable tool for teaching different subjects in schools. Generally, schools pupils love computer games and inculcating subjects and topics into computer digital game may likely boost pupils' interest and achievement, especially in an abstract subject like mathematics. Mathematics computer digital games are games and devices designed for fun and which require human efforts, activities and logical thinking to produce accurate results.

Mathematics computer digital games are softwares built in electronic devices which require human skills, logical calculations, consideration of rules with results, objectives and goals in mind. In other words, mathematics computer digital games are devices installed with software designed for play and leisure, which entail competition between two or more people which are accompanied with rules and regulations for the operations. Abonyi, et al (2014) describe mathematical games as a type of play that follows a set of rules, aims at definite goals or outcome and involves competition against other players. Students spend a lot of time using games devices and playing games. The use of those same games devices with mathematical contents may facilitate teaching and learning of mathematics in schools and may lead to improved mathematics achievements.

Achievement is the end product of actions and activities and the end product of a process. The attainment of pre-designed learning at the end of specified learning activities is referred to as achievement. In the view of Nadu (2017), achievement is a person's strong performance in a given field. Achievement is sometimes reported in line with gender analysis but the argument about the gender that performs better in mathematics has not been resolved. Gender is the natural state of identity and recognition as either male or female.

Based on this background, this study specifically intends: (1) to determine the effect of mathematics computer digital game and conventional method on achievement of mathematics in primary school. (2) To ascertain the influence of gender on mathematics achievement among primary school pupils; and (3)to find out the interaction effect of the teaching strategies and gender on the achievement of mathematics among primary school pupils.

Three research questions guided the study and they are: What is the effect of mathematics computer digital games and conventional method on the achievement of mathematics in primary school? What is the influence of gender on the achievement of mathematics in primary school? What is the interaction effect of instructional strategies and gender on the achievement of mathematics in primary school? Similarly, three null hypotheses guided the study and were tested at 0.05 level of significance. They are in the study. They are (1).There is no significant difference in pupils' achievement of primary school mathematics exposed to mathematics computer digital games and those exposed to conventional methods. The influence of gender on pupils' achievement of mathematics in primary school is not significant. And (3).The interaction effect of instructional strategies and gender on pupil's achievement of mathematics in primary school is not significant.

Method

The study adopted a quasi-experimental research design to determine the effect of mathematics computer digital games on achievement of primary school mathematics. Specifically, non-equivalent control group design was used. It is a most powerful and valid design which can be used to identify confidently the cause of any given effect (Nworgu, 2015). This study was conducted in Nigeria's Federal Capital Territory (FCT) Abuja. Abuja has six area councils; these include Abaji, Abuja, Bwari, Kwakwalada, Kuje and Kwali. Abuja Metropolitan Area Council was chosen because of persistent poor mathematics achievement of public primary school pupils in the area. A total of 145 (68 males and 77 females) were drawn from ten public primary schools in AMAC. Purposive sampling technique was adopted. Simple random sampling was used to draw six intact classes from the ten public primary schools earlier drawn. Regarding the study inclusion criteria, the researchers included those school children that have access to social media platform. These are children in the urban area whereby electricity (power) is relatively regular. This is to avoid disruption during the experimental sessions.

Mathematics Computer Digital Game and lesson plans were developed by the researchers. Addition of 3-digit numbers, addition of 3-digit numbers with regrouping, and Counting in groups. Mathematics contents used for the study were drawn from primary three school mathematics curriculum as provided by the Universal Basic Education Board. The researchers developed a total of six lesson plans. These were based on the aspects of mathematics taught. Each group (treatment and control) has a different lesson plans for the selected topics. They were validated by mathematics teachers and corrections were made in the lesson plans used. The instrument used for data collection is

a 24-item mathematics test. The summary of the 24-item mathematics tests results on pre-test and post-test were used. The same instrument was used for both the experimental and control groups. The test covered the content which has to do with addition of 3-digit numbers, addition of 3-digit numbers with regrouping, and counting in groups. The validation was done by three mathematics lecturers and the corrected version was used for the study.

Control of Extraneous Variables.

In the process of carrying out this study, the researchers applied the following measures to minimize the research threats: **Pretest-posttest:** Pretest was administered to the subjects and this helped the researchers to establish the homogeneity of the subjects. It also helped the researchers to attribute the additional posttest mean scores as a result of the treatment. **Intact Class:** The use of intact classes in both experimental and control groups helped to remove the threat of selection bias. It also took care of Hawthorne effect which might have resulted when the students become aware that they are being used for an experiment. **Researchers/Teachers Bias:** In order to avoid the researchers' bias, the researchers were not involved in teaching the students. The students were taught by their mathematics teachers, and were unaware that research was going on. Besides, different teachers taught in the experimental and control groups. This implies that the differences in posttest mean scores were not due to the differences in the teachers' personalities. **Intergroup Variables:** Because intact classes were used, it implies that initial equivalence was not achieved for the subjects in both groups. The researchers applied Analysis of Covariance (ANCOVA) which helped to eliminate the error of non-equivalence of subjects arising from the non-randomization of the subjects. **Subject Interaction**: The researchers used different schools for the experimental and control groups to avoid errors that might arise as a result of interactions and change of ideas between the subjects in both groups.

Experimental Procedure

Before the commencement of the experiment, the subjects were assigned to both the experimental and control groups. In assigning the subjects to the groups, three classes made up of 73 pupils were assigned to the experimental group and another three classes made up of 73 pupils were equally assigned to the control group. This means that a total number of one hundred and forty-five (145) pupils were used. It was based on this that the two groups were made. The subjects in both groups were pre-tested with the Mathematics Achievement Test (MAT). After the pre-test, the designed packages for teaching of mathematics began with the researchers working

strictly with the available instructional packages developed after the review of related studies. The experiment was built into the normal school calendar, in line with school timetable which lasted for 6 weeks.

In the experiment, the pupils were given the Mathematics Computer Digital Games (MCDG), for finding the sum of Three-Digit Numbers. These were designed to show the effectiveness of place value number. The game showed why regrouping is important for addition of numbers. The pupils added three digit numbers using MCDG. In the next step, the pupils practiced three digit numbers with regrouping of numbers one after the other applying mathematics digital computer game. Furthermore, the pupils applied MCDG in solving Counting of Number in groups. On the other hand, the conventional or lecture method was applied in teaching the control group. The major difference is the instructional procedure. The Mathematics Computer Digital Games required the use of mathematics computer digital games in teaching. Therefore, the MCDG was used for the treatment group while the conventional method was used for the control group.

At the end of the experiment, post-test was administered on the subjects in the two groups. Items in the post-test package were reshuffled after the pre-test but, the content remained the same. Data collected from both the pre-test and post-test of both groups were separated and analyzed using mean and standard deviation for research questions and analysis of Covariance (ANCOVA)at an alpha level of 0.05 level of significance. ANCOVA was applied because it always helped to compensate for any pre-existing difference that might have existed between the experimental and control groups in the application of pretest-posttest research.

Results.

Table 1: **Pretest and posttest mean achievement scores of mathematics in primary school taught using mathematics computer digital game and conventional method.**

Variable		**Pre-test**		**Post-test**		
Teaching Strategies	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean gain**
MCDG	73	2.33	0.22	3.51	0.27	1.18
Conventional Method	72	2.29	0.21	2.96	0.28	0.67

Summary of results were presented above. The summary result presented in Table 1 shows the pretest and posttest mean achievement scores of mathematics in primary schools taught using mathematics computer digital games and conventional method. The result indicates that the pre-test achievement mean of pupils taught using mathematics computer digital games

was 2.33, with a standard deviation of 0.22 and a posttest mean achievement score of 3.51, with a standard deviation of 0.27. The mean gain between the pretest and posttest mean achievement scores of mathematics was 1.18. The summary results also show that the control group had a pretest mean achievement score of 2.29, with a standard deviation of 0.21 and a posttest mean of 2.96, with a standard deviation of 0.28. The mean gain between the pretest and posttest mean achievement scores of mathematics low achievers in the control group was 0.67.

Table 2: **Analysis of Covariance (ANCOVA) of the difference in the achievement of mathematics in primary schools exposed to mathematics computer digital games and conventional method.**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	13.772[a]	4	3.442	47.388	.000
Intercept	20.620	1	20.620	283.792	.000
PreInt	1.147	1	1.147	15.788	.000
Strategies	13.054	1	13.054	178.666	.000
Gender	.599	1	.599	8.249	.005
Strategies * Gender	.015	1	.015	.205	.651
Error	10.245	141	.073		
Total	1566.467	145			
Corrected Total	24.017	144			

The result in Table 2 shows that an F-ratio of 178.666 with associated probability value of 0.000 was obtained with respect to the difference in the achievement of mathematics in primary school exposed to mathematics computer digital games and those exposed to conventional method. Since the associated probability (0.000) was less than 0.05 set as criterion for taking a decision, the null hypothesis two (H_{01}) was hence rejected.

Table 3: **Pretest and posttest means of the influence of gender on the achievement of mathematics in primary school.**

Variable		**Pre-test**		**Post-test**		
Gender	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean gain**
Male	68	2.31	0.20	3.21	0.38	0.9
Female	77	2.32	0.22	3.27	0.41	0.95

The summary of the result in Table 3 showed that male had a pretest mean achievement score of 2.31, with a standard deviation of 0.20 and a posttest mean achievement score of 3.21, with a standard deviation of 0.38. The mean gain between the pretest and posttest mean interest score was 0.9. The results also indicated that females had a pretest mean achievement score of 2.32, with a standard deviation of 0.22 and a posttest mean interest score of 3.27, with a standard deviation of 0.41 with mean gain of 0.95.

The result in Table 2 also indicated that an F-ratio of 8.249, with associated probability value of 0.005, was obtained with respect to the influence of gender on achievement of mathematics in primary schools. Since the associated probability (0.005) was less than 0.05 set as the benchmark for taking a decision, the null hypothesis three (H_{03}) was therefore rejected.

Table 4: **Pretest and posttest means of the interaction effect of instructional strategies and gender on achievement of mathematics in primary school**

Variable			**Pre-test**		**Post-test**		
Instructional Strategies	**Gender**	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean gain**
MCDG	Male	35	2.39	0.21	3.46	0.29	1.07
	Female	38	2.29	0.23	3.61	0.28	1.32
CONV	Male	34	2.18	0.12	2.91	0.28	0.73
	Female	38	2.36	0.23	2.99	0.28	0.63

The summary of the results in Table 4 show the interaction effect of instructional strategies and gender on achievement of mathematics in primary school. The result indicates that the males taught using mathematics computer digital games had a pretest mean score of 2.39, with a standard deviation of 0.21 and a posttest mean of 3.46, with a standard deviation of 0.29. The mean gain between the pretest and posttest means was 1.07. The female had a pretest mean achievement score of 2.29, with a standard deviation of 0.23 and a posttest mean of 3.61, with a standard deviation of 0.28. The mean gain between the pretest and posttest means for the female group was 1.32. For both male and female groups taught with mathematics computer digital games the posttest mean achievement scores were greater than the pretest means with the females having a slightly higher mean gain than their male counterparts. The results also indicated that male taught using the conventional method had a pretest mean achievement score of 2.18, with a standard deviation of 0.12 and a posttest mean of 2.91, with a standard deviation of 0.28.

The mean gain between the pretest and posttest means was 0.28 while the female had a pretest mean achievement score of 2.36, with a standard

deviation of 0.23 and a posttest mean of 2.99, with a standard deviation of 0.28. The mean gain between the pretest and posttest means for the female group was 0.63. The result in Table 2 also showed that an F-ratio of 0.205 with associated probability value of 0.651 was obtained with respect to the interaction effect of instructional strategies and gender on mathematics achievement in primary school. Since the associated probability (0.651) was greater than 0.05 set as criterion for taking a decision, the null hypothesis three (H_{03}) was accepted.

Discussion

The result from this study indicated that pupils exposed to Mathematics computer digital games indicated higher achievement in mathematics compared to those exposed to conventional method. This is in line with the study carried by Aremu and Adebagbo (2016) which reported significant difference in the achievement of students exposed to game-based strategy compared to those exposed to conventional method. The findings of this study is also in line with the result of the study carried out by Ezeugwu, Onuorah, Asogwa and Ukoha (2016) which reported that "the use of Game-based instructional technique in teaching affects students achievement in mathematics and interest in Algebra. This shows that Game-based instructional technique enhanced students' achievement in Algebra, compared to students exposed to the conventional method. Therefore, the conclusion drawn was that there is significant difference in the achievement of mathematics in primary school exposed to mathematics computer digital games and those exposed to conventional method. This implies that mathematics computer digital games tend to enhance the achievement of mathematics more than the conventional method.

The findings of this study also indicated that gender has influence on achievement of mathematics in primary schools in Abuja Nigeria. This finding is in agreement with the finding of Gambari, Olumorin and Yusuf (2013) which reported that students' gender has influence on their achievement in physics. The findings of this study indicated that the interaction effect of instructional strategies and gender has no significant effect on the achievement of mathematics in primary schools. Hence, the conclusion drawn was that the interaction effect of instructional strategies (mathematics computer digital games and conventional method) and gender on mathematics achievement of pupils in primary schools was not significant. These findings are in line with the findings of Ezeugwu et al (2016) which reported that the interaction effects of instructional strategies and gender on the interest and achievement of mathematics low achievers is not significant.

For both male and female groups taught with the conventional method, the posttest means were greater than the pretest means, with males having a higher mean, gain than their female counterparts. However, for the two instructional strategies, the posttest mean achievement scores were greater than the pretest means with female having a slightly higher mean gain than those taught with mathematics computer digital games than their male counterparts, while the males had a slightly higher mean gain when taught with the conventional method strategy than their female counterparts.

Conclusion

The study has shown that mathematics computer digital games enhanced the achievement of mathematics more than the conventional method did. This means that pupils taught using mathematics computer digital games had enhanced achievement compared to their counterparts taught using conventional method. The influence of gender on the achievement of mathematics in primary school favoured the females more than their male counterparts. There was no significant interaction effect of instructional strategies and gender on mathematics achievement of mathematics in primary schools.

Recommendations

Based on the findings of the study, the researcher made the following recommendations:

1. Teachers in primary school should be made to use mathematics computer digital games at that level to enhance the achievement of mathematics.
2. Federal government should incorporate mathematics computer digital games into the school curriculum and teachers should be trained adequately to implement mathematics computer digital games in primary schools to enhance mathematics achievement.
3. Federal and States governments should take up the task of investing into the provision of mathematics teaching aids, including computers in primary schools to enhance learning.

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