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Comparative Effects of Interactive and Non-Interactive Multimedia on Achievement in Geometry of Secondary School Students in Federal Capital Territory, Nigeria

Adewale Olanrewaju Sunday[1], Uche Scholastica Anaduaka[2], Robert G. Dajal[3]
[1,2,3]University of Abuja, Nigeria

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ABSTRACT

Objective: *This study compared the effects of interactive and non-interactive multimedia on achievement in geometry of secondary school students.* ***Method:*** *The study was carried out in Federal Capital Territory of Nigeria and adopted a pretest-posttest control group research design comprising three groups made up of two experimental groups and a control group. The sample for the study comprised 98 senior secondary one (SS1) students drawn from three co-educational schools in Federal Capital Territory of Nigeria who were all taught Geometry. In the study, intact class of 33 students were taught with interactive multimedia, another intact class of 32 students were taught with non-interactive multimedia while another intact class of 33 students were taught with conventional method. The instruments used for data collections were 30 items Geometry Achievement Test (GAT) with reliability index of 0.82. Data collected were analyzed using mean and standard deviation to answer the research questions and ANCOVA to test all the hypotheses at 0.05 level of significance.* ***Results:*** *Findings revealed that there was significant difference in the achievement scores in favour of students taught Geometry with interactive multimedia over those taught with non-interactive multimedia and conventional methods. It also revealed that there was no significant difference in the achievement mean scores of male and female students taught geometry with either interactive or non-interactive multimedia.* ***Novelty:*** *Based on the findings, recommendations were made on the need to use interactive multimedia for teaching and learning of Geometry.*

INTRODUCTION

Mathematics keeps advancing in response to the development in the branches of science that requires mathematical expressions to preserve the discovered scientific knowledge. Teaching and learning of Mathematics is of concern to all the stakeholders in education sector as contents, pedagogy and medium of instruction are of great importance for the learning of the subject. Media is a tool which is used to store or deliver information [1]. Media such as text, image, audio, video, animation and graphics may be used separately or combined together in teaching and learning process. Multimedia is the usage of more than one form of communication at the same time. Multimedia is derived from two words 'Multi and medium'. It is defined as multiple media that can be used to deliver information digitally [2].

Multimedia is a field with a computer-controlled combination of text, animation, graphics, audio, video, images and other forms of media. Multimedia presents, stores and transmits all information digitally. Multimedia refers to an application that integrates different media, such as text, graphics, video, and sound. Multimedia is a method of communications incorporating a combination of media, such as audio, video, text,

graphics, and white boarding, perhaps on an interactive basis. It is a combined use of media, such as movies, music, lighting, and the internet for education, entertainment, or advertising. Multimedia is relating to the combined use of several media. According to Alina, multimedia is characterized by the presence of text, pictures, sound, animation and video; some or all of which are organized into some coherent program [3].

Importance of multimedia in daily life cannot be exhausted as it has become an enormous strength in today's world of technology. The influence of multimedia can be seen in every aspect of human life. According to StudySection, multimedia is applied in business for presentation, training, marketing, advertising, product demos, and networked communication on products; In journalism multimedia is applied for production of magazine, newspapers, photographs; in the entertainment industry to develop special effects in movies and video games. The use of multimedia in the gaming industry made it possible to make interactive games that integrate audio and visual effects to make video games more fascinating [4].

In education, multimedia has been found to increase learning effectiveness and is more productive than traditional learning methods by invoking and sustaining interest need of students in their studies to enhance achievement. Students taught mathematics using multimedia (either interactive or non-interactive) performed significantly better than those taught using paper folding, and learning with multimedia is gender friendly [5]. Study from Bright also showed that multimedia instructional approach enhances students' achievement in mathematics across gender and ability levels. However, instructional video used by Abubakar enhanced the academic achievement of Social Studies students, but female students achieved better than male students after exposure to instructional video. This makes gender to be opened to further studies. Multimedia can either be interactive or non-interactive in usage. Interactive multimedia in this context is the teaching approach where lessons were delivered by teachers with multimedia that support user interference in its usage and progress; while non-interactive multimedia is the teaching approach where lessons were delivered by teachers with multimedia that does not support user interference in its usage and progress [6], [7]. It is against this background that this research set out to ascertain the comparative effects of interactive and non-interactive multimedia on secondary school students' achievement in geometry. Gender inclination to the two multimedia types was also determined.

Purpose of the Study

The purpose of this study was to investigate the effects of interactive and non-interactive multimedia on interest, achievement and retention of secondary school students in Geometry. Specifically, the objectives of the study were to find out;

1. The difference in the mean achievement scores of students taught Geometry with interactive multimedia, non-interactive multimedia and conventional method;
2. The difference in the mean achievement scores of students taught Geometry with interactive multimedia based on gender;

3. The difference in the mean achievement scores of students taught Geometry with non-interactive multimedia based on gender.

Research Questions

To achieve the stated objectives of the study, the following research questions were raised to guide the study:

1. What is the difference in the mean achievement scores of students taught Geometry with interactive multimedia, non-interactive multimedia and conventional method?
2. What is the difference in the mean achievement scores of students taught Geometry with interactive multimedia based on gender?
3. What is the difference in the mean achievement scores of students taught Geometry with non-interactive multimedia based on gender?

Hypotheses

The following null hypotheses were tested at 0.05 confidence level:

Ho_1: There is no significant difference in the mean achievement scores of students taught Geometry with interactive multimedia, non-interactive multimedia and conventional method.

Ho_2: There is no significant difference in the mean achievement scores of students taught Geometry with interactive multimedia based on gender.

Ho_3: There is no significant difference in the mean achievement scores of students taught Geometry with non-interactive multimedia based on gender [8].

RESEARCH METHOD

The research design for the study was quasi-experimental. Specifically, the study adopted the non–equivalent control group design which makes use of pretest, treatment, posttest and post-posttest. The design was adopted based on the fact that students were taught Geometry with one of interactive multimedia, non-interactive multimedia or conventional method in their intact classes. In other words, there was no randomization of the students for the treatments. The design is represented as follows:

Group 1	O_1	X_1	O_2	O_3
Group 2	O_1	X_2	O_2	O_3
Group 3	O_1	X_3	O_2	O_3

Where:

O_1 is the pretest question given to establish homogeneity of the three groups;
X_1 is the treatment with interactive multimedia (Experimental group l);
X_2 is the treatment with non-interactive multimedia (Experimental group 2);
X_3 is the treatment with conventional teaching method (Control group);
O_2 is the posttest question given to the three groups to measure achievement; and
O_3 is the post-posttest question given to the three groups to measure retention.

The dependent variables in this study are interest, achievement and retention in Geometry, while the independent variables are the treatment with interactive

multimedia, non-interactive multimedia and conventional method. The intervening variable in the study is the gender of the participating students.

The population of the study is 31,964 which is the total number of all the SS1 students in FCT as at 2022. The sample size for this study was 98 SS1students (43 male, 55 female) drawn from three senior secondary schools in FCT. Purposive sampling technique was used to select three schools in FCT that are coeducational and adequately equipped for multimedia teaching approach. Each school was randomly assigned by simple balloting to Interactive Multimedia Treatment Group (IMTG), Non-interactive Multimedia Treatment Group (NMTG), and the Control Group (CG). Table 1 shows the distribution of the students according to group (treatment) and gender.

Table 1. Distribution of Sample by Treatment Groups and Gender

Treatment Group	Male	Female	Total
Interactive M. M.	15	18	**33**
Non-Interactive M.M.	15	17	**32**
Conventional	13	20	**33**
Total	**43(44%)**	**55(56%)**	**98(100%)**

Table 1 shows that intact class of 33 students (15 male, 18 female) was assigned to interactive multimedia treatment group; intact class of 32 students (15 male, 17 female) was assigned to non-interactive multimedia treatment group; and intact class of 33 students (13 male, 20 female) was assigned to conventional group.

An instrument and lesson plans were used for the study. The research instrument was Geometry Achievement Test (GAT) which consisted of 30 objective questions that were developed by the researchers based on the mathematics contents/concepts that were taught during the experiment. The GAT was administered both as pretest (pre-GAT) and posttest (post-GAT). The pre-GAT was used to establish the geometry entry behaviour of the students before treatment. The items in the pre-GAT instrument were the same but juggled to have a different arrangement for the post-GAT instrument. The posttest was used to determine the extent of students' geometric achievement after they were exposed to interactive, non-interactive multimedia teaching approaches and conventional method.

To develop the GAT, a Test Blueprint or Table of Specification was constructed using the thirteen (13) units taught during the period of the study. These identified units were based on Senior Secondary School Mathematics Curriculum for SS1 (FME, 2007). The basic guiding principle that was employed in developing the test blue print was the objectives of the content area studied. The items of the instrument were developed to cover questions on recalling, understanding and application, and higher thinking processes. The internal consistency reliability index of GAT was determined using Kuder Richardson formula 20 (K-R20) because of different levels of difficulty of the multiple-choice items that were dichotomously scored. The internal consistency reliability index

of GAT was 0.82. The index obtained (0.82) qualified the instrument as reliable to use for data collection acccording to Frankmikel and Wallan (1993) who recommended a minimum of 0.70 relaibility index for a research purpose.

The three groups were taught by their respective Mathematics teachers who were research assistants in this study. Each research assistant was trained by the researchers specifically to implement the lesson plans assigned to the group they teach. This was done a week before the start of the experiment. The students in the selected classes were subjected to pretest to ascertain their corresponding entry behaviours. The classes were randomly assigned to treatment groups. In the experimental groups, each class that was taught using multimedia had their lessons in the school's ICT room and the content covered each day was loaded into computer system and projected on screen on daily basis by the schools' ICT staff. The pre-recorded video lessons were used to teach the students. The class teacher in the course of playing the video lesson had opportunity to pulse the video for further explanation to students in interactive multimedia lesson class, whereas, in the non-interactive multimedia lesson class, the students were allowed to watch the video under the guidance of the teacher without further explanation. Meanwhile, the other group was taught without using multimedia. To ensure homogeneity of instructions, the participating students' notebooks were checked at regular intervals by the researchers to make sure that their notes were up-to-date as compared with their counterpart in the other groups. The period of the teaching lasted eight weeks within the term where geometry topics were taught after which respondents were subjected to the posttest. The GAT was scored over 100 percent.

Data collected through the administration of the instruments was classified into pretest and posttest for the three groups, as well as into male and female, since the study had concern for gender as moderating factor. Data collected were analyzed with respect to the research questions and hypotheses formulated for the study. Descriptive statistics of mean and standard deviation were used to answer all the research questions. Inferential statistics of Analysis of Covariance (ANCOVA) was used to test all the hypotheses at significant level of 0.05. LSD Post Hoc Test was also used where necessary.

RESULTS AND DISCUSSION

Results

The null hypothesis is accepted if the p-value is greater than the level of significance, and rejected if the p-value is less than level of significance at 5% level of significance or 95% level of confidence.

Research Question 1: What is the difference in the mean achievement scores of students taught Geometry with interactive multimedia, non-interactive multimedia and conventional method?

Table 2. Mean and Standard Deviation of Interactive Multimedia, Non-Interactive Multimedia and Conventional Groups in Posttest of Geometry Achievement Test

Group	N	Mean	SD
Interactive M. M.	33	80.53	8.55
Non-Interactive M.M.	32	75.96	7.91
Conventional	33	52.17	8.68

Table 2 shows the mean achievement scores of interactive multimedia, non-interactive multimedia and conventional groups in the posttest of GAT. It shows that the interactive multimedia group had a mean achievement score of 80.53 with a standard deviation of 8.55; the non-interactive multimedia group had a mean achievement of 75.96 with a standard deviation of 7.91; while the conventional group had a mean achievement score of 52.17 with a standard deviation of 8.68. Therefore, the mean difference in achievement scores between interactive multimedia and non-interactive multimedia groups is 4.57 *(i.e. 80.53 minus 75.96)* in favour of interactive multimedia group; the mean difference in achievement between interactive multimedia and conventional groups is 28.36 *(i.e. 80.53 minus 52.17)* in favour of interactive multimedia group; while the mean difference in achievement scores between non-interactive multimedia and conventional groups is 23.79 *(i.e. 75.96 minus 52.17)* in favour of non-interactive multimedia group [9].

Ho_1: There is no significant difference in the mean achievement scores of students taught Geometry with interactive multimedia, non-interactive multimedia and conventional method.

Table 3. ANCOVA Results of Achievement Scores of Students Taught Geometry with Interactive Multimedia, Non-Interactive Multimedia and Conventional Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	15510.618[a]	6	2585.103	36.544	0.000
Intercept	11566.165	1	11566.165	163.502	0.000
Pretest	24.573	1	24.573	.347	0.557
Group/Method	15416.458	2	7708.229	108.965	0.000
Error	6437.370	91	70.740		
Total	495152.652	98			
Corrected Total	21947.988	97			

Sig. at $p \leq 0.05$

Table 3 shows the ANCOVA result of achievement scores of students taught Geometry with interactive multimedia, non-interactive multimedia and conventional method. From the Table, there is significant difference in achievement in Geometry among the groups based on methods; $F(2, 91) = 108.965$, $P(0.000)$ is less than 0.05 level of significance. Therefore, hypothesis one is rejected as it can be concluded that methods of teaching the groups have significant impacts on the achievement of students in Geometry [10].

Table 4. LSD Post Hoc Test Results of Achievement Scores of Students Taught Geometry with Interactive Multimedia, Non-Interactive Multimedia and Conventional Method

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
Interactive M.M.	Non-Interactive M.M.	4.55983*	2.08165	0.031
	Conventional	28.35545*	2.06558	0.000
Non-Interactive M.M.	Interactive M.M.	-4.55983*	2.08165	0.031
	Conventional	23.79563*	2.08165	0.000
Conventional	Interactive M.M.	-28.35545*	2.06558	0.000
	Non-Interactive M.M.	-23.79563*	2.08165	0.000

Dependent Variable: ACHIEVEMENT POSTTEST, Sig. at $P \leq 0.05$

Table 4 shows that the significant difference recorded in Table 3 was as a result of significant difference that exists between mean achievement of students taught Geometry with interactive multimedia and that of those taught with non-interactive multimedia. It is also as result of significant difference that exists between mean achievement of students taught Geometry with non-interactive multimedia and that of those taught with conventional method [11].

Research Question 2: What is the difference in the mean achievement scores of students taught Geometry with interactive multimedia based on gender?

Table 5. Mean and Standard Deviation of Achievement Scores of Male and Female Students Taught Geometry with Interactive Multimedia

Group	Gender	N	Mean	SD	Mean difference
Interactive Multimedia	Male	15	80.59	8.74	0.11
	Female	18	80.48	8.64	

Table 5 shows the mean and standard deviation of male and female students of interactive multimedia group with respect to their achievement scores in GAT. From the results obtained, male students had a mean achievement score of 80.59 with a standard deviation of 8.74 while the female students had a mean achievement score of 80.48 with a standard deviation of 8.64. Therefore, the mean difference in achievement scores between male and female students in interactive multimedia group is 0.11 in favour of male students [12].

Ho_2: There is no significant difference in the mean achievement scores of students taught Geometry with interactive multimedia based on gender.

Table 6. ANCOVA Results of Achievement Scores of Students Taught Geometry with Interactive Multimedia Based on Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	20.361[a]	2	10.181	0.132	0.877
Intercept	4790.493	1	4790.493	61.989	0.000
Pretest	20.260	1	20.260	0.262	0.612
Gender	0.049	1	.049	0.001	0.980
Error	2318.389	30	77.280		
Total	216322.261	33			
Corrected Total	2338.750	32			

Sig. at $p \leq 0.05$

Table 6 shows the ANCOVA result of achievement scores of male and female students taught Geometry with interactive multimedia. From the table, there is no significant difference in Geometry achievement between male and female students taught Geometry with interactive multimedia at 0.05 level of significance F(1, 30) = 0.049, P(0.980) is greater than 0.05. Therefore, hypothesis two is not rejected as it can be concluded that gender of students taught Geometry with interactive multimedia does not have significant impact on the achievement of students in Geometry.

Research Question 3: What is the difference in the mean achievement scores of students taught Geometry with non-interactive multimedia based on gender?

Table 7. Mean and Standard Deviation of Achievement Scores of Male and Female Students Taught Geometry with Non-interactive Multimedia

Group	Gender	N	Mean	SD	Mean difference
Non-interactive Multimedia	Male	15	75.92	9.35	0.08
	Female	17	76.00	6.68	

Table 7 shows the mean and standard deviation of male and female students of non-interactive multimedia group with respect to their achievement scores in GAT. From the results obtained, male students had a mean achievement score of 75.92 with a standard deviation of 9.35 while the female students had a mean achievement score of 76.00 with a standard deviation of 6.68. Therefore, the mean difference in achievement scores between male and female students in non-interactive multimedia group is 0.08 in favour of female students.

Ho_3: There is no significant difference in the mean achievement scores of students taught Geometry with non-interactive multimedia based on gender.

Table 8. ANCOVA Results of Achievement Scores of Students Taught Geometry with Non-Interactive Multimedia Based on Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	95.550[a]	2	47.775	0.751	0.481
Intercept	2721.258	1	2721.258	42.805	0.000
Pretest	95.501	1	95.501	1.502	0.230
Gender	0.008	1	0.008	0.000	0.991
Error	1843.621	29	63.573		
Total	186604.009	32			
Corrected Total	1939.171	31			

Sig. at $p \leq 0.05$

Table 8 shows the ANCOVA result of achievement scores of male and female students taught Geometry with non-interactive multimedia. From the table, there is no significant difference in Geometry achievement between male and female students taught Geometry with non-interactive multimedia at 0.05 level of significance F(1, 29) = 0.000, P(0.991) is greater than 0.05. Therefore, hypothesis three is not rejected as it can be concluded that gender of students taught Geometry with non-interactive multimedia does not have significant impact on the achievement of students in Geometry [13], [14].

Discussion

The following are the findings of this study based on the analyses:

1. There is significant difference in the mean achievement scores of students taught Geometry with interactive multimedia, non-interactive multimedia and conventional method. Those taught Geometry with interactive multimedia significantly achieved better in Geometry than those taught Geometry with both non-interactive multimedia and conventional methods. Also, those taught Geometry with non-interactive multimedia significantly achieved better in Geometry than those taught Geometry with conventional method.
2. There is no significant difference in the mean achievement scores of students taught Geometry with interactive multimedia based on gender. In other word, male and female students have equivalent achievement in Geometry when taught with interactive multimedia.

There is no significant difference in the mean achievement scores of students taught Geometry with non-interactive multimedia based on gender. In other word, male and female students have equivalent achievement in Geometry when taught with non-interactive multimedia [15].

CONCLUSION

Fundamental Finding : The finding of this study confirmed that students taught using multimedia performed significantly better than those taught using paper folding

by Isaac, Gideon and Gabriel and that of Bright who concluded that Multimedia Instructional Approach enhanced students' achievement in mathematics (Geometry inclusive) across ability levels. The conclusion of Abubakar also support this study that multimedia enhanced the academic achievement of students, not only in Geometry, but also in Social Studies. The finding of Oviawe and Uddin that male and female students achieved alike in audio-visual resources as an instructional strategy in technical colleges in Geometry also agrees with the finding of this study. Abdulkarim, Bomala and Abimbola was able to show that ICT driven pedagogy (multimedia inclusive) is superior to the conventional approach in fostering students' achievement in geometry which is in agreement with the findings of this study. However, findings further revealed that achievement of students taught Geometry with interactive multimedia retained significantly higher than that of those taught with non-interactive multimedia. **Implication :** Interactive multimedia should be integrated to the teaching and learning of Geometry in senior secondary schools by mathematics teachers to teach geometrical topics. Mathematics teachers of senior secondary schools should be trained by government and school authorities on the use of interactive-multimedia for teaching and learning of Geometry. **Limitation :** The study was limited to the teaching and learning of Geometry using interactive and non-interactive multimedia among senior secondary school students. **Future Research :** There is frequent need for seminars and workshop to be organized for teachers by National Mathematical Centre (MAN), Science Teachers Association of Nigeria (STAN), Nigerian Mathematical Society (NMS) and other related bodies, on the use of interactive multimedia in teaching Geometry.

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***Adewale Olanrewaju Sunday (Corresponding Author)**
University of Abuja, Nigeria
Email: sunday.olanrewaju@uniabuja.edu.ng

Uche Scholastica Anaduaka
University of Abuja, Nigeria
Email: uche.anaduaka@uniabuja.edu.ng

Robert G. Dajal
University of Abuja, Nigeria
Email: robert.dajal@uniabuja.edu.ng