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Effect of Mathematical Modeling-Based Teaching Activities on Basic Eight Students' Retention in Mathematics in Bayelsa State, Nigeria

Dr. Bolouembeledo FEKUMO [1], Dr. Onoge HONMANE [2]

[1] Department of Science Education, Federal University Otuoke, Bayelsa State, Nigeria
[2] Department of Science Education, Federal University Wukari, Taraba State, Nigeria

Abstract: The purpose of this study was to determine the effect of mathematical modelling-based teaching activities on basic eight students' retention in mathematics. The study was carried out at Yenagoa Local Government Educational Zone of Bayelsa State with a population of 3,693 basic eight students in the 35 basic schools, it used a quasi-experimental design of non-randomized pre-test post-test control group design. A sample of 182 out of this population was used. To arrive at this, intact classes were used. The research instrument was Mathematics Retention Test (MRT), which was used for collection of data. The MRT was trial-tested using Kuder-Richardson K-R20 and had a reliability index of 0.84. Three research questions were asked and answered using means, standard deviation and Scattergram. The three hypotheses formulated were tested at 0.05 level of significance using Analysis of Covariance. It was found that Students in the experimental group improved more in their mathematics retention than those in control group. Male and female Basic Eight students taught mathematics using Mathematical modeling-based teaching activities improved in their mathematics retention. However, the male improved more, and this was statistically significant, Basic Eight students' retention in Mathematics using Mathematical modeling-based teaching activities is not dependent on gender. It was therefore, recommended that Mathematics teachers should employ Mathematical modeling-based teaching activities in their mathematics classes which could make the students' active participants in the teaching and learning process which would improve their retention rate among others.

Keywords: Mathematics, Students' Retention, Mathematical Modeling-Based Teaching Activities.

Background of the Study

Mathematics is very important in enhancing as well as sustaining of human subsistence, since Mathematics is all about proffering solutions to human problems (Unodiaku, 2013). In spite of the fact that Mathematics is important and popular among Nigerian students, it is very disappointing to note that students' retention in the subject has remained consistently low (Ajai and Imoko, 2015).

Retention is one major concern in Mathematics education research. Retention which is the ability to reproduce the learnt concepts and skills when the need arises has been researched by many researchers. Students' achievement could be affected if they do not remember what was taught in the class during an examination. Inability of students to retain what they have learnt has been observed as one of the contributing factors to students' low achievement in Mathematics. Retention is the ability to remember things. To Hornby in Kurumeh, Onah and Mohammed (2012), it is the ability to

remember experiences and things learnt. This implies that the amount of Mathematics knowledge acquired and stored in memory, the skill maintained, or problem-solving behaviours should manifest consistently.

Retention in Mathematics is not acquired by mere rote-memorization but through appropriate teaching methods (Chianson in Safo, Ezenwa & Wushishi, 2013). In line with this, Chianson, Kurumeh and Obida (2011) identify how well students retained the knowledge of Mathematics and scientific concepts taught can be traced back to the teaching method used. The conventional method of teaching which is centered on rote-memorization does not seem to establish the connection between Mathematics concepts learnt in the classroom and their applicability to real life situation. To ascertain this, Oludipe and Oludipe (2010) point out that the traditional teaching method is a process of transmission of knowledge from teacher to students and it is essentially a one-way process. Traditional teaching method is often teacher-centered, with the teacher lecturing at the board and providing solutions to Mathematical problems while the students sit passively taking notes (Brahier, 2013).

Many students turn out to be very despondent and inattentive in class after being taught Mathematics and discover they could not memorize or recall concepts with ease. The reason for this difficulty may vary but mostly has to do with teaching methods being used to explain concepts. Thus, this study was also to find out if the adoption of Mathematical modeling-based teaching activities will enhance students' retention of Mathematics concepts they are exposed to.

In recent times, the gender factor has assumed prominence in Mathematics education discourse. It is worthwhile to profer solutions to this existing concern about students' low retention of the Mathematics knowledge acquired.

Purpose of the Study

The purpose of this study was to find out the effectiveness of Mathematical modeling-based teaching activities on students' retention when used to teach Mathematics. Specifically, the study:

1. determine if Basic Eight students improved upon their retention in Mathematics due to the use of Mathematical modeling-based teaching activities.
2. ascertain if mean retention differ between male and female Basic Eight students taught Mathematics using Mathematical modeling-based teaching activities.
3. find out the interaction effect between gender and mathematical modeling-based teaching activities on Basic Eight students' retention in Mathematics.

Research Questions

The following research questions guided the study.

1. what are the mean retention scores of Basic Eight students taught Mathematics using mathematical modeling-based teaching activities and those taught without mathematical modeling-based teaching activities?
2. what are the mean difference in retention scores between male and female Basic Eight students taught Mathematics using mathematical modeling-based teaching activities?
3. what is the interaction effect between gender and mathematical modeling-based teaching activities on Basic Eight students' retention in Mathematics?

Hypotheses

The following research hypotheses formulated were tested at 0.05 level of significance.

1. There is no significant difference between the mean retention scores of Basic Eight students taught Mathematics using Mathematical modeling-based teaching activities and those taught without Mathematical modeling-based teaching activities.

2. There is no significant difference between the mean retention scores of male and female Basic Eight students taught Mathematics using Mathematical modeling-based teaching activities.
3. There is no significant difference in the interaction effect of Mathematical modeling-based teaching activities between male and female Basic Eight students' retention in Mathematics.

Methodology

The research design for this study was quasi-experimental. Precisely, the study used a non-randomized pre-test post-test control group design. The subjects of the study were not randomized into experimental and control groups but were left as intact classes. This was to avoid the disruption of the school programmes. However, the study was conducted in Yenagoa Local Government Educational Zone, Bayelsa State, Nigeria. The population of this study was 3,693 Basic Eight pupils from the 35 State owned government basic schools in the study area. The sample was obtained using a multistage sampling procedure. Simple random sampling was used to select two schools from 35 basic schools. The choice of Basic Eight was purposive. This was basically because it allows for the modeling of mathematical topics for the benefit of the students. In addition, Basic Eight students receive more consistent academic coverage than Basic Seven students. The sample size for this study was 182 students. This was made of 66 students for the experimental group and 116 students for the control group. The choice of which schools and classes to be used as experimental and control was done through simple random sampling with the use of flip of a coin. The Instrument of the study was Mathematics Retention Test (MRT). In order to evaluate the experimental and control groups' capacity for memory retention, Mathematics Retention Test (MRT) was given to both groups two weeks after a Mathematics Achievement Test (MAT) was done. Items along with answer options of questions were shuffled around and used in the study to lessen test familiarity. Five experts—two math education experts, two math teachers, and one measurement and evaluation expert—validated a first Mathematics Achievement Test with 55 items and a marking scheme to ensure its content validity. The experts evaluated if the test items complied with the specification table, whether the study's material was effectively covered, and whether each item's agreement with the response, its clarity, and its suitability for the questions were all satisfactory. The test items' suitability for exposing the students' cognitive, emotional, and psychomotor conflicts was evaluated. Lastly, the examination does not have a discernible pattern of answers at the time of testing, to validate that the test items are placed in order of complexity from simple to complex and assessed. The changes were applied to the remaining unsuitable elements to create the final instrument, which had 50 MAT. It has a 0.84 dependability index. Prior to the study, pre-MAT was given to the respondents and collected. Once more, following the study, the research assistants administered and gathered post-MAT from the respondents. After that, both groups received the MRT two weeks later. Mean, standard deviation, and scattergram data were used to respond to research questions. In the MRT, the level of retention was calculated using the mean difference. Analysis of covariance (ANCOVA) at a significance level of 0.05 was used to test the research hypotheses.

Results

Research Question 1

What are the mean retention scores of Basic Eight students taught Mathematics using Mathematical modeling-based teaching activities (MMTA) and those taught without Mathematical modeling-based teaching activities? Answer to this research question is presented in Table 1.

TABLE 1: MEAN RETENTION SCORES AND STANDARD DEVIATION OF BASIC EIGHT STUDENTS IN EXPERIMENTAL AND CONTROL GROUPS.

Groups	N	Post-MAT		MRT	
		Mean	SD	Mean	SD
Experimental	66	34.50	7.07	31.74	7.15
Control	116	26.61	6.62	22.98	6.13
Mean Difference		**7.89**		**8.76**	
Total	**182**				

Table 1 shows that for post-test, the MMTA had a mean achievement score of 34.50 while the control group had a mean achievement score of 26.61. Their mean difference is 7.89. For retention-test scores, the MMTA had a mean retention score of 31.74 while the control group had a mean retention score of 22.98. Their mean difference is 8.76.

Research Hypothesis 1

There is no significant difference between the mean retention scores of Basic Eight students taught Mathematics using Mathematical modeling-based teaching activities and those taught without Mathematical modeling-based teaching activities. The test result of this research hypothesis is presented in Table 2.

TABLE 2: ANALYSIS OF COVARIANCE RESULT OFBASIC EIGHT STUDENTS IN EXPERIMENTAL AND CONTROL GROUPS IN MATHEMATICS RETENTION TEST

Source of Variance	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9287.104[a]	2	4643.552	522.346	.000	.854
Intercept	13.297	1	13.297	1.496	.223	.008
POST-MAT	6059.312	1	6059.312	681.603	.000	.792
GROUPS	**130.503**	**1**	**130.503**	**14.680**	**.000**	**.076**
Error	1591.275	179	8.890			
Total	135423.000	182				
Corrected Total	10878.379	181				

a. R Squared = .854 (Adjusted R Squared = .852)

Table 2 shows that, the MMTA mean retention test is F (1, 179) = 14.68, P = 0.00 < 0.05 level of significance. Thus, there is significant difference between mean retention scores of students taught Mathematics in favour of the experimental group. Hence, the null hypothesis of no significant difference is rejected.

Research Question 2

What are the mean difference in retention scores between male and female Basic Eight students taught Mathematics using Mathematical modeling-based teaching activities? Answer to this research question is presented in Table 3.

TABLE 3: MEAN RETENTION SCORES AND STANDARD DEVIATION OF MALE AND FEMALE BASIC EIGHTSTUDENTS IN THE EXPERIMENTAL GROUP.

Gender	N	POST-MAT		MRT	
		Mean	SD	Mean	SD
Male	34	33.71	7.60	32.32	7.09
Female	32	35.34	6.49	31.13	7.27
Mean Difference		**1.63**		**1.19**	
Total	**66**				

Table 3 shows that in the post-MAT, the MMTA male students had a mean achievement score of 33.71 while the female students had 35.34 mean score. Their mean difference is 1.63. In the MRT, the MMTA male students had 32.32 mean retention score while the female students had 31.13 mean retention score. Their mean difference is 1.19.

Research Hypothesis 2

There is no significant difference between the mean retention scores of male and female Basic Eight students taught Mathematics using Mathematical modeling-based teaching activities. The test result of this research hypothesis is presented in Table 4.

TABLE 4: ANCOVA RESULTS OF BASIC EIGHTMALE AND FEMALE STUDENTS IN EXPERIMENTAL GROUP IN MATHEMATICS RETENTION TEST

Source of Variance	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2628.885[a]	2	1314.442	119.368	.000	.791
Intercept	1.036	1	1.036	.094	.760	.001
POST-MAT	2605.205	1	2605.205	236.585	.000	.790
GENDER	**116.230**	**1**	**116.230**	**10.555**	**.002**	**.143**
Error	693.736	63	11.012			
Total	69823.000	66				
Corrected Total	3322.621	65				

a. R Squared = .791 (Adjusted R Squared = .785)

Table 4 shows that, the MMTA mean retention scores of male and female students is F (1, 63) = 10.56, P = 0.00 < 0.05 level of significance., the null hypothesis of no significant difference is rejected. This means that there is a significant retention in the Mathematics taught in favour of male students.

Research Question 3

What is the interaction effect between gender and Mathematical modeling-based teaching activities on Basic Eight students' retention in Mathematics? Answer to this research question is presented in Figure 1.

Linearity Scatter Gram for Male and Female Basic Eight students in Experimental Group in Mathematics Retention Test (MRT)

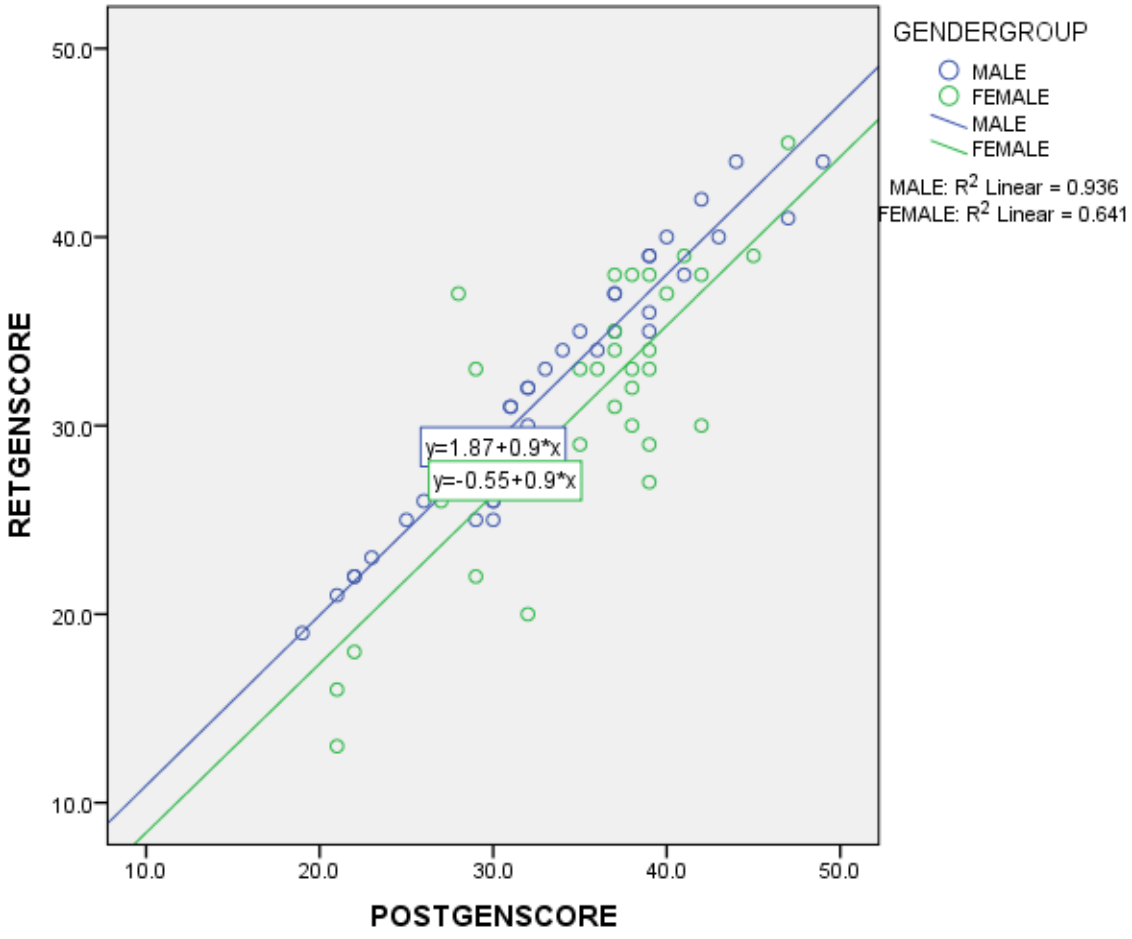

Figure 1: Scatteredgraph of interaction effect between gender and mathematical modeling-based teaching activities on basic eight students in MRT

Figure 1 shows that the two lines representing the male and female variables of gender on Mathematics retention test are parallel. The line both rise above the y-axis to the top left of the x-axis. Their respective R-square values or the coefficient of determination, variance explained, the squared correlation are 0.936 x 100 = 94% for the male and 0.641x100 = 64% for the female. This is an indication that there is no interaction effect in MMTA between male and female students' retention in Mathematics. In order words, it is an indication that Basic Eight students' retention in Mathematics using MMTA is not dependent on gender.

Research Hypothesis 3

There is no significant difference in the interaction effect of Mathematical modeling-based teaching activities between male and female Basic Eight students' retention in Mathematics. The test result of this research hypothesis is presented in Table 5.

TABLE 5: ANCOVA RESULTS OF INTERACTION EFFECT OF MATHEMATICAL MODELING-BASED TEACHING ACTIVITIES BETWEEN MALE AND FEMALE BASIC EIGHTSTUDENTS MEAN RETENTION SCORES IN MATHEMATICS.

Source of Variance	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2628.925[a]	3	876.308	78.321	.000	.791
Intercept	1.076	1	1.076	.096	.757	.002
Method	2511.209	1	2511.209	224.443	.000	.784
Gender	3.640	1	3.640	.325	.571	.005
Method*Gender	**.041**	**1**	**.041**	**.004**	**.952**	**.000**
Error	693.696	62	11.189			
Total	69823.000	66				
Corrected Total	3322.621	65				

a. R Squared = .791 (Adjusted R Squared = .781)

From the values of Table 5, it is observed that the Method variable had a significance value of (0.00) less than the threshold value (0.05) while Gender had a significance value of (0.57) more than the threshold value (0.05). Again, the interaction between the two factors Method*Gender had a significance value of (0.95) more than the threshold value (0.05). That is F(1, 62) = 0.00, P = 0.95 > 0.05. Thus, the null hypothesis of no significant difference was not rejected. It is therefore conclude that, there is no statistically significant interaction effect in the MMTA between male and female students' retention in Mathematics.

Summary of Major Findings

Based on the analyses of data from the study, the following major findings were glaring:

1. Students in the experimental group improved more in their mathematics retention than those in control group. This was also statistically significant.
2. Male and female Basic Eight students taught mathematics using Mathematical modeling-based teaching activities improved in their mathematics retention. However, the male improved more and this was statistically significant.
3. Basic Eight students' retention in Mathematics using Mathematical modeling-based teaching activities is not dependent on gender. The method is none discriminatory.

Discussion of Findings

The result has shown that Basic Eight students in the experimental group improved in their Mathematics retention more than students in the control group. From the test of hypothesis, it revealed that, there was a significant difference in the retention of experimental and control groups in Mathematics. This implies that using Mathematical modeling-based teaching activities in teaching Mathematics improved Basic Eight students' retention in Mathematics. This result is in line with studies of Gambari, Falode, and Adegbenro (2014) who found that the students taught geometry

using computer animation model performed significantly better in retention test than their counterparts. This could be as a result of students-centred learning.

Similarly, the result shows that the male and female Basic Eight students improved in their retention when exposed to Mathematical modeling-based teaching activities. However, the male were better in their Mathematics retention. Thus, test of hypothesis reveals that, there is significant difference in the retention of Basic Eight male and female students taught Mathematics using Mathematical modeling-based teaching activities. This result is contrary to the findings of Ajai and Imoko (2015) who revealed that male and female students taught algebra using PBL did not significantly differ in their retention scores, thereby revealing that male and female Basic Eight students are capable of competing and collaborating in Mathematics. In addition, this finding showed that retention is a function of orientation and gender.

Finally, Basic Eight students' retention in Mathematics using Mathematical modeling-based teaching activities is not dependent on gender. Thus, test of hypothesis reveals that, there was no significant difference between the interaction effect of Mathematical modeling-based teaching activities and gender on students' retention in Mathematics.

Recommendations

Recommendations based on the findings of this study were made as follows:

1. Mathematics teachers should employ Mathematical modeling-based teaching activities in their mathematics classes which could make the students' active participants in the teaching and learning process. This would improve their retention rate.
2. To enable both male and female students taught Mathematics retain equally in their Mathematics retention rate, Mathematics teachers should expose to both the male and female students same learning opportunities of Mathematical modeling-based teaching activities.

Conclusion

In conclusion, the utilization of Mathematical modeling-based teaching activities in the teaching and learning of mathematics gave significant improvement both in retention with respect to gender. In other words, the use of Mathematical modeling-based teaching activities in teaching mathematics enhanced retention irrespective of gender.

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