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Redirecting Basic Eight Students' Attitude towards Mathematics Via The Utilisation of Mathematical Modeling-Based Teaching Activities in Bayelsa State, Nigeria

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ABSTRACT
This study investigated the effectiveness of Mathematical Modeling-based teaching activities on students' attitude towards Mathematics. The study was conducted in Yenagoa Local Government Area of Bayelsa State in Nigeria. It adopted a quasi-experimental non-randomized pre-test post-test control group design with a population of 3,693 students in the 35 basic schools. A sample of 182 out of this population was used. To arrive at this, intact classes were used. Instrument for data collection was, Mathematics Attitude Inventory (MAI) which was validated by experts. MAI was trial-tested using Cronbach-alpha and had a reliability coefficient of 0.89. Descriptive statistic was used to answer all the research questions asked, while inferential statistic was used to test all the research hypotheses formulated at α=0.05 level of significance. It was found that Basic Eight Students' attitude towards Mathematics improved when taught using Mathematical Modeling-based teaching activities. Also, there was no gender difference found in the students' attitude towards Mathematics. Suggestions based on the findings were equally made. That, the serving teachers should use Mathematical Modeling-based teaching activities to improve students' attitude towards Mathematics.

KEYWORDS: Students' Attitude, Mathematics, Mathematical Modeling-Based Teaching Activities, Basic Eight.

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I. BACKGROUND OF THE STUDY

Mathematics, no doubt, remains one of the most useful subject to all disciplines as well as human endeavors. The need to acquire Mathematics knowledge all over the world has become very obvious. This is because Mathematical knowledge is essential to every one's life (Mensah, Okyere & Kuranchie, 2013). This implies that Mathematics is useful in domestic and business deals, scientific discoveries, technological breakthrough, problem-solving and decision making in different situations in life (Usman & Nwoye, 2010). It may be due to the importance of Mathematics, that in Nigeria, national policy on education made Mathematics a core subject both at primary and secondary school levels (Federal Republic of Nigeria (FRN), 2014).

The problem of Mathematics learning has been persistent and is topical and attracts the attention of researchers (Shafi & Areelu, 2010; Pasha, Rao & Veerababu, 2012). Several studies have been conducted in different countries in order to find out students' attitude towards Mathematics (Tahar, Ismail, Zamani & Adnan, 2010; Tezer & Karasel, 2010; Maat & Zakaria, 2010). Students come into the Mathematics classroom with already biased conception of Mathematics as a very difficult subject, very abstract and therefore hard to understand (Njoku, 2010). Attitude is defined by Olatoye and Aderogba (2012) as a psychological construct, or latent variable inferred from observable responses to stimuli which are assured to mediate consistency and coherence among those responses. Students with negative attitude towards learning will have no meaningful learning as such could neither pass nor continue in his/her education. Students' attitude according to Fatoke and Olaoluwa (2014) can play a substantial role among students studying a subject.

Yılmaz, Altun, and Olkun (2010) identified teaching method among others as factors related to students' attitude towards learning of a subject. In this respect, the learner draws from his teachers' disposition to form his own attitude, which may likely affect his learning outcomes (Yara in Mensah, Okyere & Kuranchie, 2013). This implies that, there is a relationship between attitude and method of instruction, especially as could be in modeling.

Attitude can also be gender related. Gender is the properties that distinguish organism on the basis of their reproductive roles as female or male (Abubakar & Uboh, 2010). In recent times, the gender factor has assumed prominence in Mathematics education discourse. There are many who hold the view that Mathematics

is masculine in nature. This belief tends to affect the attitude of females students towards Mathematics. Nonetheless, some studies have found gender difference in students' attitude toward Mathematics. Compared to males, females had debilitating causal attributional patterns, perceived Mathematics as a male domain (Casey, Nuttal & Pezaris in Mensah, Okyere & Kuranchie, 2013). Moreso, Ayub, Riasat, Zahidullah, Imtiaz & Asfandyar (2017) found that girls have negative attitude towards Mathematics. In contrary, Kannan, Sivapragasam and Senthilkumar (2015) in their study also found that in secondary school, female students have a better attitude towards Mathematics than that of male students. Also, Aysun (2017) determined students' attitudes towards Mathematics and found statistically significant difference in favour of female towards Mathematics. Meanwhile, Osman and Majeed (2017) findings of their study in terms of gender difference towards Mathematics revealed that males and females, generally had similar attitude towards Mathematics. Also, Galadima and Okogbenin (2012) revealed that there was no significant difference on students' attitude in terms of gender when Mathematical games are used. It appears that gender differences in Mathematics are inconclusive and need further enquiry in this study to justify the claims of other researchers.

Today nations all over the world including Nigeria expect Mathematics teachers to raise individuals who are able to create effective solutions in cases of real life problems and use Mathematics effectively in their daily lives. Thus, students will enjoy Mathematics instead of being scared of it. Therefore, it is worthwhile to profer solutions to this existing concern, students' nonchalant attitude towards Mathematics. Pedagogical approaches that improve students' attitude ought to be used by Mathematics teachers. One of such approaches is Mathematical modeling approach. Mathematical modeling approach is solving of complex, practical and open problems with the help of Mathematics. According to Heck (2010), Mathematical modeling-based teaching activities make contribution to meaningful learning of Mathematics topics and concepts. Mathematical modeling involves using Mathematics symbols, syntax and concepts to distill key elements of real-world phenomena in order to articulate the relationships among these elements (Spandaw, 2011).

Hence, this study was poised to determine if Mathematical modeling-based teaching activities is adopted, it will enhance basic eight students' attitude towards the learning of Mathematics irrespective of gender.

Objective of the Study

The purpose of this study was to find out the effectiveness of Mathematical modeling-based teaching activities when used to teach Mathematics at the Basic Education level. Specifically, the study find out:

1. if Basic Eight students would improve upon their attitude towards Mathematics due to the use of Mathematical modeling-based teaching activities.
2. the attitude of male and female Basic Eight students taught Mathematics using Mathematical modeling-based teaching activities.
3. the interaction effect of Mathematical modeling-based teaching activities on male and female basic eight students' attitude in Mathematics.

Research Questions

The following research questions guided the study.

1. What are the mean attitude ratings 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 attitude ratings of male and female Basic Eight students taught Mathematics using Mathematical modeling-based teaching activities?
3. What is the interaction effect of Mathematical modeling-based teaching activities on male and female basic eight students' attitude 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 attitude ratings 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 attitude ratings of male and female Basic Eight students taught Mathematics using Mathematical modeling-based teaching activities.
3. There is no significant difference between the interaction effect of Mathematical modeling- based teaching activities on male and female basic eight students' attitude in Mathematics.

II. METHODOLOGY

The study adopted a quasi-experimental of non-equivalent group design. Precisely, it used a non-randomized pre-test post-test control group design. A non-randomized pre-test post-test control group design was used as both experimental and control groups were not equal in size and treatment, intact classes were therefore used.

The study was carried out in Yenagoa Local Government Area of Bayelsa State, Nigeria. The Local Government Area is located in the Central Senatorial District of Bayelsa State with the headquarters at Yenagoa, the state capital. It has an area of 706 km². The choice of Yenagoa Local Government Area of Bayelsa State was because of consistent poor Mathematics achievement noticed at the Basic Education level.

The population for this study was 3,693 Basic Eight students in the 34 public basic schools in Yenagoa Local Government Area of Bayelsa State (Bayelsa State Post Primary Schools Board, 2019). Basic Eight (BE) was chosen because it is part of the foundation where Mathematics concepts can be modelled for better understanding of the students. Also, students in BE 8 have relative stability in terms of subject coverage more than BE 7.

The sample size of this study was 182 out of 3,693 BE students in their intact classes from two out of 34 Basic Schools in the Local Government Area. The sample consists of both male and female students in the control and experimental groups in their intact classes. To obtain this sample, multistage sampling technique was used. Firstly, the local government area was purposively chosen for the study. Simple random sampling techniques was used for the selection of the schools and the experiment and control groups. For the students, all the students in their intact class participated in the study.

A Mathematics Attitude Inventory (MAI) containing 30 items was used for the study. It solicited for information on students' attitude towards Mathematics. Items contained in the inventory includes both positive and negative statements about students' attitude towards Mathematics. MAI is a four point scale of Strongly Agree, Agree, Disagree and Strongly Disagree. Positive statements were rated 4,3,2,1 respectively while negative statements were rated in the reverse order of 1,2,3,4 where the higher value 4 takes the most negative option which is Strongly Disagree.

The Mathematics Attitude Inventory was face and content validated by five experts, two measurement and evaluation experts, one psychologist, one Mathematics educator and one Mathematics teacher. These experts assessed the inventory to find out whether the items conform to the subject matter they are supposed to measure, whether the items are clear, readable and free from ambiguity for the level of students they are designed for. The experts brought out the general observations and suggestions for the improvement of the instrument. Their suggestions led to the final form of the inventory. Its reliability index is 0.89.

Pre-MAI was administered before the study. While, post-MAI was administered after the study by the research assistants.

Data collected were analyzed using descriptive and inferential statistics. Research questions were answered using mean and standard deviation. An overall mean of 2.5 and above was considered to have had positive attitude while below 2.5 was considered to have had no positive attitude in MAI. The research hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance.

III. RESULTS

The result of the study is presented according to research questions asked and hypotheses formulated.

Research Question 1

What are the mean attitude ratings of Basic Eight students taught Mathematics using Mathematical modeling-based teaching activities and those taught without Mathematical modeling-based teaching activities?

Answer to this research question is presented in Table 1.

TABLE 1: MEAN ATTITUDE RATINGS AND STANDARD DEVIATION OF BASIC EIGHT STUDENTS IN EXPERIMENTAL AND CONTROL GROUPS

Groups	N	Pre-MAI		Post-MAI	
		Mean	SD	Mean	SD
Experimental	66	1.47	0.22	2.63	0.21
Control	116	1.35	0.16	1.85	1.17
Mean Difference		**0.12**		**0.78**	
Total	**182**				

Table 1 shows in the pre-MAI a mean attitude ratings of students in the experimental group as 1.47 with standard deviation of 0.22, while the mean attitude ratings of students in the control group was 1.35 with a standard deviation of 0.16. Their mean difference is 0.12.

In the post-MAI, students in the experimental group had mean attitude ratings of 2.63 with standard deviation of 0.21 and the control group had mean attitude ratings of 1.85, with a standard deviation of 1.17. The difference between the experimental and control groups post-MAI mean attitude ratings is 0.78. This implies an improvement in basic eight students' attitude towards Mathematics during the period of this study.

Research Hypothesis 1

There is no significant difference between the mean attitude ratings 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: ANCOVA RESULT OF BASIC EIGHT STUDENTS, IN EXPERIMENTAL AND CONTROL GROUPS IN MATHEMATICS ATTITUDE INVENTORY

Source of Variance	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	23807.881[a]	2	11903.941	463.151	.000	.838
Intercept	7222.234	1	7222.234	280.998	.000	.611
PRE-MAI	1057.883	1	1057.883	41.159	.000	.187
GROUPS	**17773.065**	**1**	**17773.065**	**691.503**	**.000**	**.794**
Error	4600.674	179	25.702			
Total	772729.000	182				
Corrected Total	28408.555	181				

a. R Squared = .838 (Adjusted R Squared = .836)

The results in Table 2 shows that p=.00 while set p-value is 0.05, it indicates that p<0.05. Hence, the null hypothesis is rejected. This means that there is a significant difference between the Basic Eight students taught Mathematics with mathematical modeling-based teaching activities and those taught without mathematical modeling-based teaching activities in their attitude towards Mathematics.

Research Question 2

What are the mean attitude ratings of 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 ATTITUDE RATINGS AND STANDARD DEVIATION OF MALE AND FEMALE BASIC EIGHT STUDENTS IN THE EXPERIMENTAL GROUP

Gender	N	Pre-MAI		Post-MAI	
		Mean	SD	Mean	SD
Male	34	1.41	0.19	2.56	0.18
Female	32	1.51	0.23	2.69	0.22
Mean Difference		**0.1**		**0.13**	
Total	**66**				

Table 3 shows in the pre-MAI that the mean attitude ratings of male and female Basic Eight students in the experimental group were 1.41 and 1.51 respectively with corresponding standard deviations of 0.19 and 0.23. Their mean difference is 0.1.

In the post-MAI, the mean attitude ratings of the male and female Basic Eight students were 2.56 and 2.69 respectively with corresponding standard deviations of 0.18 and 0.22. Their mean difference is 0.13. This is in favour of basic eight female students.

Research Hypothesis 2

There is no significant difference between the mean attitude ratings 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 RESULT OF MALE AND FEMALE BASIC EIGHT STUDENTS IN EXPERIMENTAL GROUP IN MATHEMATICS ATTITUDE INVENTORY

Source of Variance	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	725.188[a]	2	362.594	12.266	.000	.280
Intercept	4577.865	1	4577.865	154.857	.000	.711
PRE-MAI	466.737	1	466.737	15.788	.000	.200
GENDER	**88.239**	**1**	**88.239**	**2.985**	**.089**	**.045**
Error	1862.402	63	29.562			

Total	412127.000	66
Corrected Total	2587.591	65

a. R Squared = .280 (Adjusted R Squared = .257)

The result presented in Table 4 shows that p=.09, while the set P-value is 0.05, it shows that p>0.05. Hence, the null hypothesis is not rejected, which implies that, there is no significant difference in the attitude of male and female Basic Eight students towards the mathematics taught using Mathematical modeling-based teaching activities during the period of this study.

Research Question 3

What is the interaction effect of Mathematical modeling-based teaching activities and gender on Basic Eight students' attitude in Mathematics?

Answer to this research question is presented in Figure 1.

Linearity Scatter Gram for Male and Female students of Experimental Group in Mathematics Attitude Inventory (MAI)

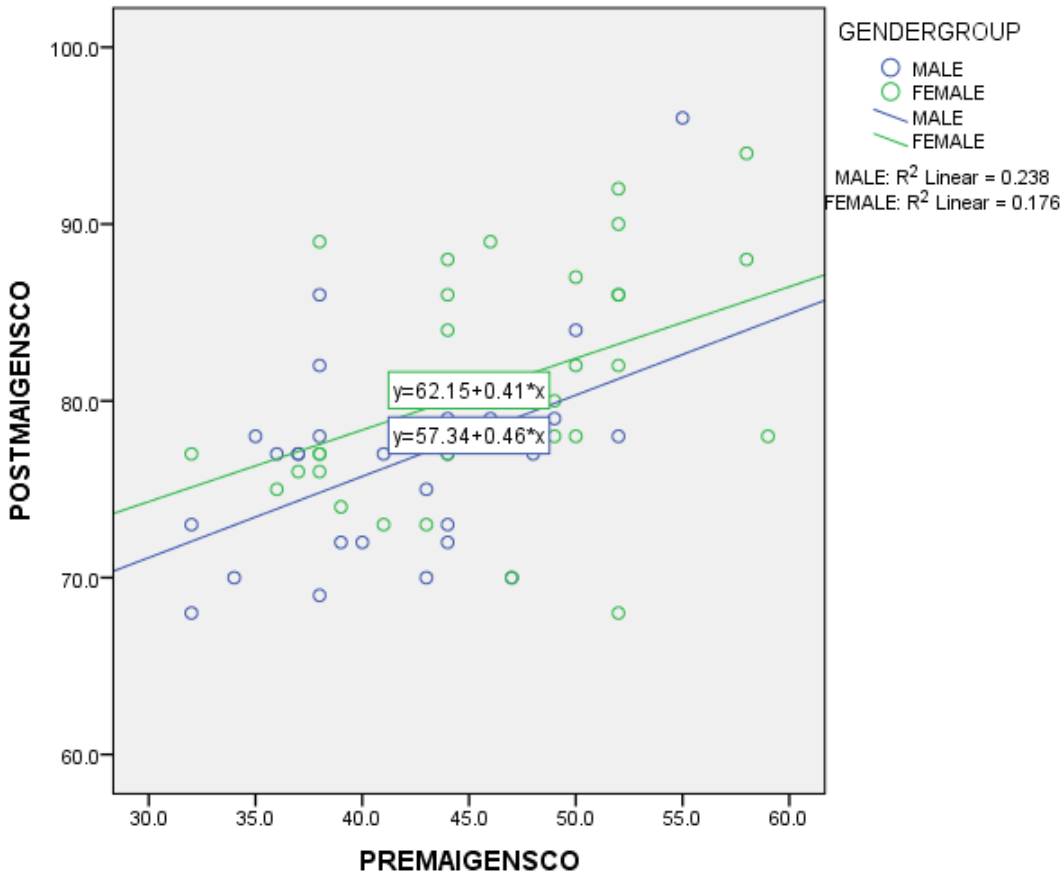

Figure 1: Scatteredgraph of interaction effect of mathematical modeling-based teaching activities on male and female basic eight students in MAI

Figure 1 shows there is a positive linear relationship in the attitude ratings of male and female Basic Eight students in learning Mathematics using mathematical modeling-based teaching activities. In the scatter plot, the two lines representing the male and female variables of gender are both parallel to one another, and they both rise on y-axis to the top right of the x-axis. Their R-square (R^2) or the coefficient of determination, variance explained, the squared correlation have such values as R^2 linear = 0.238 x 100 = 24% for male and R^2 linear = 0.176 x 100 = 18% for female. The parallel lines are indications that there is no interaction effect of mathematical modeling-based teaching activities on male and female basic eight students' attitude in learning Mathematics. In order words, it is an indication that basic eight students' attitude in learning Mathematics using mathematical modeling-based teaching activities is not dependent on gender.

Research Hypothesis 3

There is no significant difference between the interaction effect of Mathematical modeling-based teaching activities and gender on students' attitude 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 ON MALE AND FEMALE BASIC EIGHT STUDENTS MEAN ATTITUDE RATINGS IN MATHEMATICS.

Source of Variance	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	727.033[a]	3	242.344	8.076	.000	.281
Intercept	4487.920	1	4487.920	149.553	.000	.707
Method	463.819	1	463.819	15.456	.000	.200
Gender	7.264	1	7.264	.242	.624	.004
Method*Gender	**1.845**	**1**	**1.845**	**.061**	**.805**	**.001**
Error	1860.557	62	30.009			
Total	412127.000	66				
Corrected Total	2587.591	65				

a. R Squared = .281 (Adjusted R Squared = .246)

From Table 5, it is observed that, the significance values of method variable is (0.00) less than the threshold value (0.05) while that of gender variable is (0.62) more than the threshold value (0.05). Also, the interaction between the two factors Method*Gender (0.81) is more than the threshold value (0.05). That is F(1, 62) = 0.06, P = 0.81 > 0.05. Thus, the null hypothesis of no significant difference was not rejected. This implies that there is no statistically significant interaction effect of mathematical modeling-based teaching activities on male and female basic eight students' attitude in Mathematics.

IV. SUMMARY OF MAJOR FINDINGS

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

1. Students in the experimental group improved more in their attitude towards mathematics than those in control group during the period of this study. This was statistically significant.
2. Male and female Basic Eight students taught mathematics using Mathematical modeling- based teaching activities improved equally in their mathematics attitude. This was statistically significant.
3. Basic Eight students' attitude towards Mathematics using Mathematical modeling based teaching activities is not dependent on gender. The method is none discriminatory.

V. DISCUSSION OF FINDINGS

The result has shown that basic eight students improved in their attitude towards Mathematics due to the use of Mathematical Modeling-based teaching activities during the period of this study in the Mathematics classroom. This may have been as a result of the fact that these students were involved cognitively, psychomotively and affectively. Their desired involvement may have resulted to their positive attitude towards Mathematics.

The test of hypothesis assert that there is a significant difference between the students taught with Mathematical modeling-based teaching activities and those taught without Mathematical modeling-based teaching activities in their mean attitude ratings. This result is in line with studies of Isik and Pilten *(*2017) and Irfan and Jarnawi (2017) who found that the use of Mathematical modeling activities enhanced attitude towards Mathematics. This result is probably due to the fact that Mathematical modeling-based teaching activities has the capacity to greatly improve and deepen students' understanding of Mathematics.

Again, male and female Basic Eight students had a positive attitude in the experimental group after treatment was administered. The hypothesis result shows that there is no significant difference in the mean attitude ratings in Mathematics between male and female students taught with Mathematical modeling-based teaching activities. Thus, the use of Mathematical modeling-based teaching activities may be considered a more effective teaching method that promotes students attitude than the lecture method. This result is in line with the findings of Galadima and Okogbenin (2012) who found that there was no significant difference in students' attitude in terms of gender when used Mathematical games. The method is effective in bridging any existing gender gap.

Basic Eight students' attitude towards 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' attitude in Mathematics. This result agrees with Galadima and Okogbenin (2012) who indicated that there was no significant difference between male and female students' attitude in Mathematics.

VI. RECOMMENDATIONS

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

1. Mathematics Teachers should use Mathematical modeling-based teaching activities in their various Mathematics classrooms. This would enhance the students' attitude towards the subject.
2. Mathematics teachers should expose to both male and female students same opportunity to explore Mathematical modeling-based teaching activities in their mathematics classes. As such, both male and female students will have positive attitude towards Mathematics.

VII. CONCLUSION

In conclusion, the utilization of Mathematical modeling-based teaching activities in the teaching and learning of mathematics gave a clear improvement in attitude of the students towards the subject. The use of Mathematical modeling-based teaching activities in teaching mathematics has shown not to be discriminatory as there was positive attitude, irrespective of gender.

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