

## Assessing the Relative Effectiveness of Three Teaching Methods in the Measurement of Student' Achievement in Mathematics

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### Abstract

The purpose of this research work was to assess the relative effectiveness of three teaching methods on students' achievement in secondary school Mathematics. The design of the study was a quasi-experimental pretest posttest research design using intact classes. A sample of 150 students randomly selected from three secondary schools in Ogbadibo Local Government Area was used in this study. The instrument for data collection was a 25-item achievement test in mathematics (ATM) developed by the researcher for the purpose of measuring students' achievement in mathematics. The reliability coefficient for the instrument using Cronbach coefficient alpha was 0.95. In the study, two research questions were answered and two hypotheses were tested. The results indicated that students taught using activity method performed better than those taught using discussion and lecture methods; there was no significant difference in mean achievement between boys and girls when they are taught using activity method. Moreover, a significant difference exists in mean achievement scores of male and female students when they are taught mathematics using lecture method. The paper recommends among others that mathematics teachers should employ appropriate pedagogical methods in order to obviate cognitive dissonance and frustration associated with learning failures in mathematics

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**Keywords:** relative effectiveness, three teaching methods, achievement, lecture method, discussion method, activity method.

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### INTRODUCTION

There has been a drastic reduction in the standard of performance by students at all levels of education in Nigeria in the past decades. The fall in the standard of education in Nigeria is traceable to many factors which are rooted in psychological, physiological or environmental factors. Many persons seem to be perplexed as to what factors are actually responsible for the fall in standard of students' performance in schools. This puzzled state has eventually led many to attribute the fall in performance to: poor condition of service for teachers; lack of qualified teachers; inadequate supply of facilities and equipment; lack of motivation, lack of instructional materials; and wrong method of teaching (Emaikwu & Nworgu, 2005; Onah, 2012 & Emaikwu, 2012). The fall in standard of achievement by students at all levels of education has been awfully reported and acknowledged by all and sundry in Nigeria. To catch a glimpse of evidence of the terrible fall in the standard of performance in Nigeria, Agbo (2012) reported in the 'Nation Newspaper' of 4<sup>th</sup> June 2012 thus:

*The ridiculous reduction in cut-off point for admission into Nigerian universities is at variance with the standard of excellence already set by some universities. To lower the cut-off mark to 180 out of 400, which translates to a mere 45 per cent, is to assume that all the Nigerian universities would stoop*

*so low to woo failed students as their potential candidates for admission. With this policy in place in Nigeria, the international community will see nothing good in Nigerian university education which is now open to all – the good, the bad and the ugly. Unless we go back to that noble system, more than 60 per cent of candidates admitted into our universities will always be of poor quality that will surely create problems for their teachers who bear the brunt and pains of teaching “unteachable” students (p. 10).*

This fall in standard of performance at post primary level is incontrovertibly attributable to pedagogical approaches adopted by teachers in schools. It has been reported that learning and understanding of school subjects have been frustrated by the clumsy methods and instructional materials used (Etukudo, 2006). To support this assertion, Salau (2009) submitted that many researchers have adduced that poor performance in public examination is traceable to teaching techniques by teachers. The resultant effect is the low achievement and low retention level in students' outcome both in internal and external examinations. Sequel to this, there is a wide spread concern among parents and considerable public about the methods used in teaching at the secondary school level especially mathematics in Nigeria.

The inadequacy of conventional teaching models to improve students' interest, achievement and retention has become a source of concern to many educators in Nigeria. Tom (2011) is of the view that teachers should be well equipped with the necessary-teacher factors and experiences needed for use in teaching school subjects if students are to learn maximally. Instructional strategies adopted by teachers influence the cognitive, affective and psychomotor outcomes. The call for departure from the traditional method of teaching has been sounded by many mathematics educators in Nigeria with the intention of obtaining admirable results (Abakpa, 2010).

The method in any teaching and learning situation is very important because the way a teacher presents subject matter to learners may make them to like or dislike the subject. It has also been reported by Mtsem (2011) that teaching method affects the responses of students and determines whether they are interested, motivated and involved in a lesson in such way as to engage in a good learning. What constitutes good teaching and learning of school subjects is the use of appropriate methods of teaching. Ogunniyi (2009) asserted that one of the most persistent and compelling problems besetting achievement in Nigeria is poor quality of teaching. Corroborating this assertion, Harrison (2010) reported that many school subjects especially Mathematics is not being learnt as it ought to be in Nigeria because of inappropriate teaching methods. There exist a number of teaching methods available for teachers to use and they include lecture method, discussion method, demonstration method, discovery or inquiry (activity) method, laboratory method and individualized instructional. This study compares three methods (lecture, discussion and activity) of teaching mathematics with a view to determining which of them will be more effective and will result in greater learning.

Lecture method is a teaching procedure in which there is a one – way channel of communication where the teacher makes an oral presentation of the subject matter content and students react by silently listening and taking notes. In this method the teacher gives out all the facts he wants the students to know and master, caring very little if at all whether or not, the students are actively participating and contributing to the success of the lesson (Akem, 2007). This method is good for large class since much work could be easily covered in shorter time. Teaching under this method is reduced to story telling. The method reduces learners to mere note – taking and passive listeners. Learner's perception and assimilation of the subject matter is slow. Lecture method often inhibits active participation of students in the classroom and teacher dependence on the part of students (Ransdem, 2009). Abah (2006) revealed that skills are best learnt through practices rather than mere listening.

Activity method is a student –centered teaching method where students learn by doing. Herwit (2002) asserted that children learn best by doing not just by sitting and listening. This method have been found to be superior in developing students' abilities in applying concepts and personal growth, developing positive attitudes, fostering motivation, and encouraging appropriate group social skills. Using this method in teaching the teacher assumes the roles of a facilitator, mediator and assessor of learning. Activity-based- teaching featuring active students' participation in the learning process has produced superior results (Welbery, 2009). Odili (2006) reported that activity method guides learners to discover facts for themselves. Abah (2006) advised that for effective teaching of mathematics to occur, the teacher should get the learners involved as much as possible in activities that will enable them to develop that needed process skills and attitudes relevant to scientific life.

Discussion method involves a group of people in a class who come together to exchange ideas, facts, opinions and expressions orally about a topic of mutual concern and interest under a guide. In discussion class, the students talk to each other about the concept or problem until there is an agreeable understanding to it mentally. This method encourages children to be independent of teacher and discover knowledge and also see relationship on their own. The issue of gender differences in mathematics achievement has been in existence for quite a long time. Research evidence abounds to show that girls are not achieving well as expected in mathematics (Becker, 2005; Finn, 2008 & Erickson, 2009). Aiken (2007) reported that males are superior to females in mathematics. The evidence of the existence of gender gap in American secondary school mathematics was also attested by Glenn and Ashley (2009) who affirmed that there is a large gender gap that widens dramatically at percentiles above those that can be examined using standard data sources. They submitted that an analysis of unobserved heterogeneity indicates that there is only moderate variation in the gender gap across schools and that the highest achieving girls in the U.S. are concentrated in a very small set of elite schools, suggesting that almost all girls with the ability to reach high mathematics achievement levels are not doing so. On the contrary Hyde and Mertz (2009) reported that there is no gender gap among 99th percentile Asian Americans in Minnesota. However, Fryer and Levitt (2009) noted that the gender gap in their result is very consistent across demographic groups and hence their basic conclusion is that there is variation in the gender gap across schools, but that the magnitude of the variation is not very large. Guiso, Monte, Sapienza, and Zingales (2008) examine the relationship between mathematics test scores and measures of cultural, political, and

economic gender equity. They found that the gender gap in average scores is smaller in countries with greater gender equity. Hence over the years, the influence of gender difference in mathematics achievement has been a matter of concern to public. It has been shown that gender difference in performance exists with the observation that boys dominate in the use of apparatus and express more confidence of handling practical equipment. Kelly (2007) asserted that boys are ahead of girls, in every branch of science with the largest difference being in mathematics and practical test. Will this difference in achievement exist if appropriate strategy is used in teaching?

There is no single method which can be regarded as best for every teaching situation. Ada (2005) reported that there are number of criteria available that may guide the teacher in the choice of any given method of teaching which include: the content to be taught, objectives to be achieved, time available, number of students, teachers' preferences and individual differences, the type of lesson, facilities available, needs and interest of the class, among others.

Akanyi (2004) observed that students taught mathematics using activity method scored higher in achievement test followed by discussion method while field and lecture methods scored the least. This indicated that there is a significant relationship between the instructional strategies employed by teachers and students' achievements. Ojenya (2005) carried out a research on how mathematics teachers use lecture and demonstration methods in the classroom and he reported that students taught using demonstration method performed better than those students taught using the lecture method. However, the most prominently used approaches in the teaching of mathematics is the often criticized lecture method as against the activity method as advocated by educationists for teaching in Nigerian secondary schools (Ogwuozor, 2006).

Zephaniah (2006) undertook a study on the effect of using activity method in the teaching of senior secondary school mathematics on students' academic performance and he concluded that students taught mathematics via activity method have a mean score higher than their counterparts who were taught the same concept with lecture approach. The problem of this study therefore is to ascertain which of the teaching methods enhances best learning of mathematics in secondary schools.

### RESEARCH QUESTIONS

To carry out the study the following research questions were posed:

1. What are the mean achievement scores of students taught mathematics using lecture, discussion and activity methods?

2. What are the mean achievement scores of male and female students taught mathematics using lecture, discussion and activity methods?

### RESEARCH HYPOTHESES

The following hypotheses were formulated to guide the study and were tested at 5% level of significance

1. There is no significant difference in the mean achievement scores of students taught mathematics using lecture, discussion and activity methods.
2. There is no significant difference in the mean achievement scores of male and female students taught mathematics using lecture, discussion and activity methods.

### RESEARCH METHODOLOGY

The design of the study was a quasi-experimental research design. Precisely a pre-test and posttest control group design was used. To apply this design, the researcher gave the pretest to the students to determine their initial equivalence in all relevant aspects before their exposure to the treatment variables. To control for '*teacher quality variable*', all groups were taught by the regular Mathematics teachers in the selected schools. The study was carried out in Ogbadibo Local Government Area of Benue State. The population of the study comprised all the 2011/2012 students in SSS 3, studying mathematics in the mixed secondary schools in the study area. A total of 590 candidates formed the population for the study. The sample consisted of one hundred and fifty (150) SS3 students selected from three secondary schools using purposive sampling technique. Intact classes in three schools were used having a total of 85 male and 65 female students.

The instrument for data collection was a multiple-choice test consisting of a 30- item cognitive achievement test in mathematics (CATM) developed by the researcher and with its items selected from trigonometry. Each item of the instrument has five options lettered A-E with a pseudo-chance parameter of 0.20 probability of success for low ability students. Face and content validities of the instrument were ensured by three experts in mathematics education. Each of them was asked to judge the adequacy and brevity of the items of the test instrument. The experts were asked to solve the items of the test and then to indicate the correct options. Their various answers were compared and noted. Based on their comments, some items were reviewed.

The reliability coefficient of the instrument for the study was determined by using Cronbach alpha coefficient. The reliability coefficient for the cognitive achievement test in mathematics (CATM) was 0.95. At the end of the experimental exercise, all the three groups were administered the items of cognitive achievement test in mathematics (CATM).

Scores were thereafter assigned to the responses of the students in the three groups to determine the treatment effects. The research questions posed were answered using mean and standard deviation while the hypotheses formulated were tested using t-test statistic and analysis of variance at 5% level of significance.

**RESULTS OF THE FINDINGS**

**Research Question 1:** What are the mean achievement scores of students taught mathematics using lecture, discussion and activity methods? Table 1 shows the mean and standard deviation of students' scores in lecture, discussion and activity methods respectively.

Table 1: Mean and Standard Deviation of Students in Lecture, Discussion and Activity Methods

Method	N	Mean	Standard deviation
Lecture	50	15.56	5.45
Discussion	50	19.72	4.27
Activity	50	23.36	4.76

From Table1 the mean and standard deviation scores of students taught using lecture, discussion and activity method were 15.56 and 5.45, 19.72 and 4.27, 23.36 and 4.76 respectively. This implies that the performance of students taught mathematics using lecture, discussion and activity method differ from one another as can be observed from their means of 15.56, 17.72, and 23.36 respectively. To find out if the difference in means was statistically significant, the corresponding hypothesis was therefore tested.

**Hypotheses 1:** There is no significant difference in the mean achievement scores of students taught mathematics using lecture, discussion and activity methods.

Table 2: F-ratio Comparison of Three Methods of Teaching Mathematics

Source of Variation	Sum of squares	DF	Variance Estimate	F-ratio	F-critical
Between Methods	1523.25	2	761.625	40.75	3.00
Within Methods	2747.92	147	18.69		
<b>Total</b>	<b>4271.17</b>	<b>149</b>			

From Table 2, the F-ratio was 40.75 and the critical value of F for 2 and 149 degrees of freedom is 3.00. The obtained F-ratio of 40.75 is higher than the critical F-table value of 3.00; hence F is statistically significant and therefore the null hypothesis is rejected. This implies that there is significant difference in the mean achievement of students taught mathematics using lecture, discussion and activity methods.

There is the need to calculate the effect size for this independent analysis of variance (ANOVA) which yielded a statistical significant result. Effect size

statistics provide an indication of the magnitude of the difference between the groups being statistically compared. The procedure for calculating eta squared for analysis of variance is provided by the formula:

$$\eta^2 = \frac{\text{Sum of squares between group}}{\text{Total sum of squares}}$$

$$= \frac{1523.25}{4271.17} = 0.0356635301$$

The guidelines for interpreting the value of eta squared are: 0.01 = small effect, 0.06 = moderate effect, 0.14 = large effect. In this hypothesis, we can see that the effect size of 0.0356635301 is a small effect size. Expressed as a percentage, (i.e. multiply the effect size by 100), 3.6 per cent of the variance in the dependent variable could be explained by the independent variable.

**Research Question 2:** What are the mean achievement scores of male and female students taught mathematics using lecture, discussion and activity methods?

**Hypotheses 2:** There is no significant difference in the mean achievement scores of male and female students taught mathematics using lecture, discussion and activity methods. The answer to research question 2 and the result of hypothesis 2 are combined and presented in Table 3 for economy of space. To ascertain if the difference in means between the two sexes is statistically significant using any of the three teaching methods, the corresponding hypothesis 2 was therefore tested and the result presented in Table 3.

Table 3: Mean, Standard deviation and t-test Statistic of Male and Female Students taught Mathematics using Lecture, Discussion and Activity methods.

Method	Sex	N	Mean	S.D	t-cal	t-critical
Lecture	Male	29	17.59	5.64	3.81	1.96
	Female	21	12.76	3.26		
Discussion	Male	27	20.22	4.47	0.92	1.96
	Female	23	19.13	3.95		
Activity	Male	31	24.13	3.98	1.70	1.96
	Female	19	22.11	4.22		

Table 3 shows the mean and standard deviation of male and female students taught mathematics using lecture, discussion and activity methods.

From Table 3, it follows that since the t- calculated value of 3.81 > 1.96, we reject the null hypothesis that there is no significant difference between the mean achievement of the male and female students taught mathematics using lecture.

From Table 3, since the t- calculated value of 0.92 < 1.96, we accept the null hypothesis and conclude that there is no significant difference between male and

female students taught mathematics using discussion method.

In the same vein, since the t-calculated value of 1.68 < 1.96, we also accept the null hypothesis and hence conclude that there is no significant difference between male and female students taught mathematics using activity method.

### **DISCUSSION OF FINDINGS**

The results of data analysis showed a mean achievement score of 24.13 for activity method which was higher than that of discussion method with a mean value of 20.22. The lecture method according to this research was the least performing method with a mean achievement score of 17.59. The result of hypothesis one indicated that there was a significant difference in the mean achievement scores of students taught mathematics using lecture, discussion and activity methods. A high achievement was recorded when activity method was used in instructional delivery because using activity method in teaching, the teacher assumes the roles of a facilitator, mediator and assessor of learning. This therefore supports earlier report by Herwit (2007) who asserted that children learn best by doing not just by sitting and listening. The result of this study supports other researchers' assertion that activity method is superior in developing students' abilities in applying concepts, developing positive attitudes, fostering motivation, and encouraging appropriate group social skills compared to other teaching methods. The findings of the study are in conformity with Zephaniah (2006) and Welbery (2009) who also affirm that activity-based-teaching featuring active students' participation in the learning process produces superior results than lecture method. Lending credence to this result, Akanyi (2004) reports that those students taught mathematics using activity method scored higher in achievement test followed by discussion method while lecture method has the least mean score. Some people refer to lecture method as telling method and are of opinions that telling is not teaching even though the method affords the class, opportunities of obtaining useful and essential facts, information and knowledge at the minimum expense of time. Ogwuozor (2006) asserted that the most prominently used approach in the teaching of mathematics in secondary schools is the often criticized lecture method as against the activity method as advocated by some educationists. It is therefore expedient that for effective teaching of mathematics to occur, the teacher should get the learners involved as much as possible in activities that will enable them to develop the needed process-skills and attitudes relevant to life.

From Table 3, since the t- calculated value of 3.81 is greater than the t-critical value of 1.96, we reject the null hypothesis that there is no significant difference

between the mean achievement of the male and female students taught mathematics using lecture method. This implies that the mean achievement scores of male and female students are statistically different and that male students perform better than female students in mathematics when lecture method is used as a pedagogical approach. The importunate research reports that male students perform better than female students could therefore be attributable to the persistent use of the often heavily criticized lecture method in the teaching of mathematics in many schools.

From Table 3 also since the t- calculated values of 0.92 and 1.68 are less than the t-critical value of 1.96 for discussion and activity methods, we accept the null hypothesis and conclude that there is no statistically significant difference in academic achievement between male and female students taught mathematics using discussion and activity methods. This therefore implies that the two groups have relatively high scores when activity and discussion methods are used. This invariably shows that, the combination of two methods or even more methods can prove more effective in the content delivery than just using lecture method alone. Becker (2005), Aiken (2007), Finn (2008) and Erickson (2009) reported that males are superior to females in mathematics. Previous results which showed that male students perform generally better academically than their female counterparts could be attributable to wrong pedagogical approach hitherto used in schools. The previously reported high academic performances of male students over their female colleagues may be due to differences in their goals and aspirations rather than in their intellectual capabilities. Kelly (2007) in his research reported that gender difference in performance exists with the observation that boys are ahead of girls, in every branch of science with the largest difference being in mathematics and practical test. There are number of criteria available that may guide the teacher in the choice of any given method of teaching which include: the content to be taught, objectives to be achieved, time available, number of students, teachers' preferences and individual differences, the type of lesson, facilities available, needs and interest of the class. The success in using teaching methods depends on teacher's intelligent analysis of the educational purposes, the ability and nature of the students in the class and the subject matter that will be treated.

### **IMPLICATIONS**

The implication of this study is that students will benefit greatly from teaching outcomes in schools if activity method is used as a pedagogical approach in mathematics instructional delivery. Moreover, the failure rate in mathematics will decline greatly if activity-based-instructional approach is adopted by

secondary school mathematics teachers as this will go along way in reducing the abstractness and the difficulty in the study of mathematics. One of the implications of this study therefore is that mathematics teachers should put more efforts to ensure that the teaching of mathematical concepts is done with the use of activity-based-method.

Another implication of this study is that for teachers to properly use activity-based-method in instructional delivery there is the need for the Ministry of Education in Nigeria to keep organizing seminars, conferences and workshops for the in-service teachers and with little financial incentives given to them as a motivational strategy. Above all, the curriculum planners of mathematics for pre-service teachers' programmes should include this approach among other pedagogies. Since there was no significant difference in the mean achievement between boys and girls when they are taught using activity method, it implies that the use of activity-based-method in the teaching of mathematics will definitely reduce the gender gap in mathematics achievement in Nigeria.

### CONCLUSION

The result of this study has provided an empirical basis that activity method is an appropriate teaching strategy capable of improving the present dismal achievement of students in mathematics. It is therefore evident that the use of activity method enhanced student's achievement in the real sense than discussion method; while lecture method showed lowest achievement in mathematics. Based on the results of the study, it can be concluded that there was a significant difference in the mean achievement scores of students taught mathematics using the three pedagogical methods. Hence students' performances in mathematics vary significantly when lecture, discussion and activity methods are used in teaching in favour of activity method.

The result also indicated that there was a statistical significant difference between the mean achievement scores of male and female students taught mathematics using lecture methods. This implies that the mean achievement scores of male and female students are statistically different and that male students perform better than female students in mathematics when lecture method is used as a pedagogical approach.

The result equally showed that there was no statistical significant difference in mean achievement between male and female students taught mathematics using discussion and activity methods. Nevertheless, both male and female students have relatively high scores when activity method is used as pedagogical approach in instructional delivery.

### RECOMMENDATIONS

In the light of these findings, the following recommendations are made:

- ❖ For effective teaching of mathematics, attention should be given to qualified teachers to handle the teaching. Hence recruiting, preparing and training good teachers should be the central strategies for improving schools because teachers are instrumental in translating subject contents into teachable classroom lessons
- ❖ Mathematics teachers should deliver their lessons to students using activity-based method of teaching. This will invariably instill a process-skill in the students thus inducing their critical thinking and conceptual understanding.
- ❖ For effective teaching of mathematics, the teacher should get the learners involved as much as possible in activities that will enable them develop the needed process-skills. Students should be made to understand that for any meaningful learning to take place, they have to be physically involved in the learning process.
- ❖ Mathematics teachers should interact and share their experiences with one another through seminars and workshops to discover better strategies of teaching with a view to improving students' achievement in the subject.
- ❖ Mathematics teachers should be encouraged to develop creative knowledge in improvising some models and teaching aids for use during lessons to concretely impart knowledge on the concepts often taught to the learners.
- ❖ Ministries of education, curriculum planners and developers should outline appropriate activity-based instructional methods for use by teachers to teach any topic highlighted in the mathematics curriculum.

Finally teachers should always employ appropriate pedagogical methods in teaching in order to obviate cognitive dissonance and frustration associated with learning failures in mathematics.

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