

## EFFECTS OF BUTTERFLY METHOD ON ACADEMIC PERFORMANCE IN FRACTION AMONG PRIMARY SCHOOL PUPILS IN KANO STATE, NIGERIA

By

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### Abstract

*Mathematics at the primary school level is the foundation for the study of the subject at higher levels. As such, primary school mathematics needs to be taught to the pupils effectively for maximum learning outcome among children. However, there has been persistent outcry of poor performance in mathematics among primary school pupils as well as poor skills in attempting problems involving basic operations in fractions. This study examined the effects of Butterfly method on primary school pupils' academic performance in Fraction in Kano State, Nigeria. The study was guided by two (2) research questions and two (2) hypotheses which were tested at 0.05 level of significance. The study adopted the quasi-experimental pretest posttest nonequivalent control group design. The population of the study was 8,374 Primary five pupils from 44 Model Primary Schools in Kano state. Two schools were randomly selected and one intact class was randomly selected from each school. One class was randomly assigned to experimental group and the other to control group. The experimental group had 79 pupils made up of 42 boys and 37 girls while the control group had 60 pupils made up of 26 boys and 34 girls. Thus, the sample size was 139 pupils. Fraction Performance Test (FPT) with reliability coefficient of 0.81 was developed and used by the researchers to collect data. FPT contained five (5) essay questions and was administered as pretest before the commencement of the experiment to both groups. The experimental group was then exposed to butterfly method for 3 weeks while the control group was taught by the conventional lecture (LCM) method for the same duration. FPT items were reshuffled and taken as posttest by both groups. Data collected from FPT were analyzed using mean, standard deviation and t-test. Findings revealed that primary school pupils taught by using butterfly method outperformed those taught by using conventional lecture method. In terms of gender, the findings showed that girls performed significantly better than boys when taught by using Butterfly method. It was recommended that SUBEB should train and re-train primary school Mathematics teachers, through workshops and seminars, on the application and use of Butterfly method in their classrooms.*

**Keywords:** Butterfly method, fraction, performance, primary school, pupils

### Introduction

Primary Education is regarded as the foundation level for children's education in Nigeria. Mathematics teaching at the primary school level needs to be qualitative because if the foundation is weak, pupils may face difficulties at a later stage. In search of the desired quality, the Nigeria Educational Research and Development Council – NERDC (2012) revised

the primary school curricula. The objectives of the 2007 revised primary school Mathematics curriculum, among others, are to help pupils:

1. Acquire Mathematics literacy necessary to function in an information age.
2. Cultivate the understanding and application of mathematics skills and concepts necessary to thrive in the ever-changing technological world.
3. Become prepared for further studies in Mathematics and other related fields. (NERDC, 2012)

The above objectives show clearly that mathematics knowledge is required for scientific and technological development of Nigeria. This is in line with the assertion of Umar, Tudunkaya and Muawiya (2019) that the need for Mathematics knowledge in the world over has become very glaring and obvious due to its relevance to everyday life activities and in various disciplines. As important as Mathematics to the modern information age and everyday life of Nigerian children, its teaching and learning, especially at the primary school level, has remained ineffective because poor performance of primary school pupils in Mathematics has been reported. Chollom (2016) as cited by Davou (2019), while presenting a paper to mark the end of primary school quiz competition organized by Plateau State Universal Basic Education Board, lamented the sorry state of primary school mathematics and the pupils' poor performance at mathematics Olympiads organized by Mathematical Association of Nigeria (MAN) and National Mathematical Centre (NMC), Abuja. Specifically, fraction is found to be among other mathematical concepts that primary school pupils find difficult and continue to perform poorly. Chinyoka, Mutanbara and Chagwiza (2012), Lazic et al (2017) and Obande and Dogo (2018) all indicated that primary school pupils find fractions difficult to understand and exhibited poor skills to perform basic operations on fractions.

So many reasons for the difficulties faced by learners in comprehending fractions have been advanced by various scholars. For instance, Chinyoka, Mutanbara and Chagwiza (2012) argued that pupils' difficulty in learning fraction is due to their failure to develop the conceptual understanding needed to acquire the procedural knowledge of solving fractions. On the other hand, Siegler (2017) blamed the pupils' difficulty in learning fractions on two factors, inherent factors and culturally contingent factors. Inherent factors are those factors that drive from the nature of fractions such as notations used to express fractions, complex relations between fraction arithmetic and whole number arithmetic and complex conceptual relations among different arithmetic operations on fractions. Culturally contingent factors include language of describing fractions, teacher understanding of fractions and nature of fractions presentations in textbooks. Other scholars (Osakwe, Obodo and Inweregbugh, 2019) were of the view that the type of teaching method used by teachers remains one of the key reasons. Wittmann (2013) opined that most of the errors or difficulties learners have when solving problems involving operations with fractions are due to the teaching methods that mathematical content of fractions require. Lazic et al (2017) also mentioned instructional methods as one of the foundational area that needs to be considered for pupils to learn fractions in a meaningful way.

Despite the role of method of teaching in comprehending fractions, there is enough evidence showing that mathematics teachers at primary school level use traditional method with little or no consideration to innovative approaches (Yakubu, 2016; Osakwe, Obodo & Inweregbugh, 2019). This shows that there is a need for mathematics educators to try other innovative approaches to enhance learning of mathematics concepts such as fractions. One of such methods is the butterfly method.

The butterfly method is an alternative visual method for teaching fractions where the diagonal and horizontal multiplication of the denominators and numerators are employed by drawing the butterfly. The method is used to add or subtract two fractions with different denominators, without having to find the Lowest Common Multiple (LCM). From the researchers' experiences, finding LCM is a difficult task for pupils. Some scholars argued that there is no conceptual understanding in the instruction while using butterfly method and recommended that it should be used after exposing students to other methods that begins with conceptual understanding. Others criticize the method as just a 'bunch of tricks' and desired to know what happens if one is faced with addition or subtraction of three or more fractions. However, Laidin and Tengah (2021) applied the method in Brunei, Darussalam, and revealed that the method not only simplifies the learning of addition and subtraction of fractions but also indirectly enhances the conceptual understanding of the topic among students. Moreover, the method can be used to add three fractions. It only requires one to add the first two in one butterfly and add the sum to the third fraction by drawing another butterfly. Thus three fractions can be added or subtracted by using two butterflies.

The steps in using butterfly method to add or subtract fractions are outlined below:

1. Write the two fractions side-by-side as usual.
2. Draw the two wings of butterfly. The first wing along the diagonals made by the numerator of the first fraction and the denominator of the second fraction and the second wing along the diagonal made by the numerator of the second fraction and the denominator of the first fraction.
3. Draw an antenna on each wing.
4. Multiply the numbers in each wing and put the product in the antenna for the wing.
5. Connect the bottom parts of the wing with a body-like loop and multiply the two denominators it connects, putting the product inside the body.
6. Add or subtract the numbers in the antennae and put the result down.
7. Reduce or simplify to the lowest term, if necessary.

The examples below illustrate the procedure of using butterfly method to add and subtract fractions.

Examples: Simplify

$$\begin{aligned} 1. \quad \frac{1}{4} + \frac{5}{6} &\longrightarrow \begin{array}{c} \text{Antenna} \\ \text{Wing} \quad \text{Wing} \\ \frac{1}{4} + \frac{5}{6} \end{array} \longrightarrow \begin{array}{c} \text{Antenna} \quad \text{Antenna} \\ \text{Wing} \quad \text{Wing} \\ \frac{1}{4} + \frac{5}{6} \\ \text{Body} \\ \frac{6+20}{24} = \frac{26}{24} \end{array} \\ &= 1\frac{2}{24} = 1\frac{1}{12} \end{aligned}$$

$$\begin{aligned} 2. \quad & \frac{8}{9} - \frac{1}{6} \longrightarrow \begin{array}{c} \text{Butterfly Method} \\ \frac{8}{9} - \frac{1}{6} \end{array} \longrightarrow \begin{array}{c} \text{Butterfly Method} \\ \frac{8}{9} - \frac{1}{6} \end{array} = \frac{48-9}{54} \\ & = \frac{39}{54} \\ & = \frac{13}{18} \end{aligned}$$

Another area that has continued to generate debate among researchers in mathematics education is gender performance differences in mathematics. Some scholars argued that boys perform better than girls (Fajemidagba and Sulaiman, 2012; Haruna, 2012) while others contended that girls are as good as boys in mathematics performance (Yakubu, 2016). Yet some others indicated that girls perform better than boys. Even in the learning of fractions, Yusuf (2014) concluded that males and females JSS students perform equally when exposed to Computer Assisted Instruction (CAI). Also, Obande and Dogo (2018) found that male and female students in Upper Basic two class benefitted equally from Concrete Representational Abstract (CRA) strategy of teaching fractions. This shows that the debate on gender and mathematics learning is still inconclusive. Also, since the Federal Government (2004) through the National Policy on Education expects every child to have equal opportunity to attain his/her potentials irrespective of gender, then more researches such as the present one are needed to find out methods that reduce gender differences in mathematics learning and eventually contribute to the resolution of the debate on gender performance in mathematics.

Therefore, the present study is designed to investigate whether or not butterfly method could enhance primary school pupils' academic performance in fraction concept when compared to the conventional method as well find out whether gender has no effect on the pupils' performance when exposed to butterfly method.

### **Objectives of the Study**

The main objective of this study is to investigate the effects of butterfly method on academic performance in fractions. Specifically, the study is designed to:

1. Determine whether or not the butterfly method enhances academic performance in fractions among primary school pupils in Kano state.
2. Find out the difference, if any, in the academic performance of boys and girls in fraction when exposed to butterfly method.

## Research Questions

The study sought to find answers to the following questions:

1. What is the difference in the mean score of pupils taught addition and subtraction of fractions using butterfly method and those taught using conventional lecture method?
2. What is the difference in the mean score of boys and girls when taught addition and subtraction of fractions by using butterfly method?

## Research Hypotheses

The following null hypotheses were tested at  $p \leq 0.05$  level of significance:

1. There is no significant difference between the mean score of pupils taught addition and subtraction of fractions using butterfly method and those taught using conventional lecture method.
2. There is no significant difference between the mean score of boys and girls taught addition and subtraction of fractions using butterfly method.

## Methodology

Quasi-experimental design was adopted for the study. Specifically, pretest posttest nonequivalent control group design was used to conduct the study. This design is suitable because intact classes were used. The target population was 8,374 Primary five pupils from 44 Model Primary Schools in Kano state. Model primary schools are specialized Co-Educational primary schools with more qualified and specialist teachers in all the school subjects including mathematics when compared to other ordinary primary schools in the state.. The choice of Model primary schools is to control some teacher variables like quality, specialty and motivation of teachers. The choice of primary five pupils is due to the fact that addition and subtraction of fractions with different denominators is taught at primary five. A sample of two Model Primary schools from the 44 schools was selected randomly. The two schools were randomly assigned to experimental and control group. One intact class was randomly selected from each of the two selected schools. This gave a total of 79 pupils in the experimental group made up of 42 boys and 37 girls. On the other hand, the control group was made up of 26 boys and 34 girls. This gave a total of 60 pupils in the control group. Therefore, the overall total sample size for the study was 139 pupils.

The instrument used to collect data was Fraction Performance Test (FPT). FPT was an essay test made up of five items covering addition and subtraction of fractions with different denominators. FPT was validated by three experts – one expert in mathematics education, one in test and measurement and one seasoned primary school mathematics teacher. FPT has a reliability coefficient of 0.81 from test-re-test method.

In order to conduct the experiment and collect the required data, two research assistants were trained for two days. The training covered the content area and the use of FPT. FPT was then administered as pretest to establish equivalence of the groups before the commencement of the experiment. After the pretest, the experimental group was taught addition and subtraction of fractions with different denominators using butterfly method for two weeks while the control group was taught the same topics for the same duration using conventional lecture method. At the end of the experiment, PFT was reshuffled and administered as posttest to measure the effect of the treatment. Data collected from FPT was subjected to analysis using mean and

standard deviation to answer the research questions while independent t-test was used to test the formulated null hypotheses at  $P \leq 0.05$  level of significance.

## Results

**Research Question one:** What is the difference in the mean score of pupils taught addition and subtraction of fractions with different denominators using butterfly method and those taught using conventional lecture method?

Data on FPT scores for experimental and control group is presented in Table 1:

**Table 1**

*Mean and Standard Deviation of FPT Scores of Experimental and Control Groups*

Group	N	$\bar{X}$	SD	Mean Difference
Experimental	79	41.37	22.12	29.30
Control	60	12.07	15.94	

Table 1 shows that the experimental group taught using butterfly method had a mean of 41.37 with standard deviation of 22.12 while the control group exposed to conventional method of using LCM had a mean of 12.07. Therefore, the experimental group had a higher mean. The mean difference is 29.30.

**Research Question Two:** What is the difference in the mean score of boys and girls when taught addition and subtraction of fractions with different denominators by using butterfly method? Data on FPT scores for boys and girls is presented in Table 2

**Table 2**

*Mean and Standard Deviation of FPT Scores of Boys and Girls*

Group	N	$\bar{X}$	SD	Mean Difference
Boys	42	36.29	20.61	11.82
Girls	37	48.11	23.42	

Table 2 shows that boys in the experimental group taught using butterfly method had a mean of 36.29 with standard deviation of 20.61 while girls exposed to butterfly method also had a mean of 48.11. Therefore, girls had a higher mean and the mean difference is 11.82.

**Hypothesis One:** There is no significant difference between the mean score of pupils taught addition and subtraction of fractions using butterfly method and those taught using conventional lecture method.

The summary of independent t-test analysis of the mean scores of experimental and control groups is shown in Table 3:

**Table 3**

*Summary of t-test Analysis of the Mean Scores of Experimental and Control Groups in FPT*

Group	N	$\bar{X}$	SD	Df	t – Cal	P	Decision
Experimental	79	41.37	22.12	137	8.68	0.01	Significant
Control	60	12.07	15.94				

Table 3 indicated that t-calculated value is 8.68 and the P-value is 0.01. Therefore, since p-value of 0.01 is less than the alpha value of 0.05, the null hypothesis was rejected. This implies that there was a significant difference between the mean performance score of pupils taught addition and subtraction of fractions by using butterfly method and those exposed to conventional lecture method in favor of butterfly method group.

**Hypothesis Two:** There is no significant difference between the mean score of boys and girls taught addition and subtraction of fractions using butterfly method. The summary of independent t-test analysis of the mean scores of boys and girls in the experimental group is shown in Table 4

**Table 4**

*Summary of t-test Analysis of the Mean Scores of Boys and Girls in Experimental Group in FPT*

Group	N	$\bar{X}$	SD	Df	t – Cal	P	Decision
Boys	42	36.29	20.61	77	-2.38	0.019	Significant
Girls	37	48.11	23.42				

Table 4 indicated that t-calculated value is -2.38 and the P –value is 0.19. Therefore, since p-value of 0.019 is less than the alpha value of 0.05, the null hypothesis was rejected. This implies that there was a statistically significant difference between the mean performance score of boys and girls taught addition and subtraction of fractions by using butterfly method in favor of girls.

## **Discussion**

The study found a significant difference between the mean performance score of pupils taught addition and subtraction of fractions using butterfly method and those exposed to conventional lecture method in favor of the butterfly method group as shown in Table 3. This proved that butterfly method was more effective than the conventional method in teaching and learning addition and subtraction of fractions with different denominators. This finding also indicates that butterfly method could enhance the primary school pupils' performance in fractions more than the conventional method. This finding is in line with that of Laidin and Tengah (2021) who discovered that butterfly method not only simplifies the learning of addition and subtraction of fractions but also indirectly enhances the conceptual understanding of the area. The efficacy of the butterfly method can be attributed to the fact that pupils need not to find LCM when solving the given problem. So, the method does not require one to find LCM which makes the solution process easier among pupils. The visual illustration of the method also could aid pupils' memory of the solution process and this could likely impact on their performance.

The findings of the study also revealed that there was significant difference between the mean performance score of boys and girls taught addition and subtraction of fractions using butterfly method in favor of girls (Table 4). This implied that the method favors girls. It further suggests that the method could be used to reduce the gender performance difference in mathematics between boys and girls so as to help girls realize their potentialities in the study of mathematics and mathematics-related fields. This result disagreed with the findings of Yusuf (2014) and Obande and Dogo (2018) who reported that there was no significant difference in the achievement scores of males and female JSS students in fractions. The difference could be attributed to the visual illustration used in the method as girls, by their nature, appreciate and like visual designs which may arouse their interest in the method and enhance their performance.

## **Conclusion**

The following conclusions could be drawn from the findings of the study: Butterfly method enhances and improves academic performance of primary school pupils in fraction more than the conventional lecture method. Butterfly method enhances the learning outcome of primary school girls more than boys especially in the area of fractions.

## **Recommendations**

1. Primary school Mathematics teachers should be trained and re-trained, through workshops and seminars, on the application and use of Butterfly method in their classrooms.
2. Mathematics educators, professional associations in Mathematics like Mathematical Association of Nigeria (MAN) and other textbook developers should incorporate butterfly method in their future publications.



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