Effectiveness of Cooperative Learning Method in Mathematics in Nigeria: A Meta-Analysis

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Abstract

In every country, regardless of the level of economic scientific and technological development, mathematics has to be taught to a number of scientists, technical specialists, scientific researchers etc. The services of be these professionals will be continuously needed for the well-being of the people and for the development of the society. Nigeria as a country needs to strive for scientific and technological break-through in order to cater for her domestic and international needs to enable her assert her greatness among the United Nations Members States. This study aims at obtaining a general opinion about effectiveness of cooperative learning method on mathematics achievement of students with meta-analysis. Three research questions and one hypothesis guided the study. Meta-analytic research design was used for this study. Purposive sampling technique was used to draw 45studies on effect of cooperative learning on students' mathematics achievement. Research questions were answered using percentages and statistical transformations while the hypothesis was tested using Winer Combined test. The findings revealed among others that the mean effect of cooperative learning on students' achievement in mathematics is significant at 0.05 level and the percentage variance of students' achievement attributable to cooperative learning method is 29.16 %.

1. Introduction

The knowledge of mathematics is paramount in the success of every man in his numerous day to day activities in life. Mathematics is the touch stone of wit and whet stone of intelligence. It is the queen and at the same times the servant of most disciplines and also source of enlightenment of human understanding of the universe Osafehinti [14]. Mathematics education holds the potency of making individuals to relate its knowledge to everyday problem being encountered and hence develop self to a level that one is intellectually and economically stable. Right from the prehistoric days of the early human societies to the present "hitec" age, mathematics has played a fundamental role in the economic development of many counties of the world Popoola [16].

Mathematics as a language of science is a very important subject in our schools as its application cuts across all arrears of human endaviour. No wonder Udousoro affirmed that the knowledge of science remain superficial without mathematics [18]. The pertinent virtue of mathematics as well as its contributions to the development of mankind has earned the subject the prominence it enjoys among other school subjects. It is a core subject in primary and secondary school in Nigeria, also a credit pass in mathematics at the senior secondary school certificate examination is needed as a pre-requisite for admission into tertiary institutions in Nigeria. Unfortunately, students' performance in this all important subject has not been impressive. This is supported by researchers like Agwagah and Ugwuanyi that even thought the indispensability of mathematics in the development of our society has been universally acknowledged, the output of its teaching and learning is still not encouraging [1] [20].

The disheartening high failure rate in mathematics at pre-tertiary school level has bothered the minds of many researchers, authors and mathematics educators and attempts are being made to proffer some solutions. In considering ways and means of ensuring effective teaching and learning of mathematics in school that can enhance students' achievement, various teaching methods have been adopted by mathematics educators and researchers. Choosing the correct teaching method and how this method is utilized is very essential in teaching mathematics to attain good performance. Cooperative learning method is one of the various teaching methodS that have been adopted by mathematics teachers and researchers. Cooperative learning is a method of instruction characterized by students working together in small groups to reach a common goal. It is generally understood to be learning which takes place in environment where students work collaboratively in small groups by sharing ideas while working on a given task Eniayeju [3]. It is a discovery method in which small groups are used.

Cooperative learning is one of the most wide spread area of research and practice in education. A lot of

researches have been conducted on cooperative learning and students' achievement in mathematics and different results have been reported by these researchers. Researchers like Onabanjo, Olusoji, Mohammed, Okafor, Ezenworah, Eniayeju, Okigbo & Ugwu and many others worked on effect of cooperative learning on students' achievement in mathematics and reported conflicting results as some reported significant effect of the method on achievement and some others reported non-significant effect [3] [4] [7] [10] [11] [12] [13]. Due to these inconsistencies in the research findings and due to the fact that the ugly situation of persistent poor performance in mathematics has not change remarkably presupposes that other alternatives should be sought. For instance, integrating all the primary researches on effect of cooperative learning method on students' achievement in mathematics and finding the mean effect size through meta-analytic procedure. Effect size according Rosenthal is the estimate of the magnitude of the relationship between two variables [17]. Effect size provides standardized unit of measurement for determining and indicating the effectiveness of instructional practice. This effect size will be based on a standardized mean difference Cohens'd. The overall mean effect size will help to reach a generalizable conclusion if cooperative learning method is effective in teaching and learning of mathematics. Meta-analysis is defined as the study of a large body of studies using statistical procedure for the purpose of integrating, synthesizing and making sense of them Glass [5]. It is the analysis of analyses. Meta-analysis procedure focuses on combining results from different studies that address the same issues so as to bring out a composite view of the mean effect of teaching method on students' achievement in mathematics. Meta-analysis is aimed at more powerfully estimating the true effect size as opposed to a less precise effect size derived in a single study under a given single set of assumption and conditions. Therefore, the focus of this study is to determine the magnitude of the mean effect of cooperative learning method of teaching on students' achievement in mathematics in Nigeria using meta-analytic procedure.

2. Purpose of the study

The purpose of this study is to obtain a general opinion about effectiveness of cooperative learning method on mathematics achievement of students with meta-analysis. This is done by using meta-analysis procedure to determine the overall effect of cooperative learning on students' achievement in mathematics in Nigeria

3. Research Questions

The research questions that guided the study are:

- What are the results of previous studies on effect of cooperative learning method on students' academic achievement in mathematics?
- What is the effect size of each of the studies on effect of cooperative learning on students' achievement in mathematics?

What is the mean effect size of all the studies on effect of cooperative learning on students' achievement in mathematics?

4. Hypothesis

The overall effect of cooperative learning method on students' academic achievement in mathematics will not be significant at 0.05 level of significance.

5. Method

The design of this study is meta-analytic design. According to Glass meta-analytic procedure is applicable to situations in which series of research results are to be integrated to provide a conclusive end point [5]. The area of the study is Nigeria. Nigeria was chosen as the area of study because the universities and research institutes that were used in getting the data-bases are located in Nigeria. Also the study examined researches reported and carried out in Nigeria. The population of the study consisted of all published and unpublished previous research studies on effect of cooperative learning method on students' academic achievement in mathematics carried out in Nigeria between 2000 and 2013.

Purposive sampling technique was used to select forty-five qualitative studies in conference proceedings, journals, masters and doctorial thesis from university libraries and research institutes. A search procedure was executed to find results of empirical studies from published and unpublished research studies on the effect of cooperative learning method on students' academic achievement in mathematics using a coding sheet. The coding sheet consisted of items listed in a tabular form making up sections showing serial number of the study, author (s) of the study, year of the study, place of the study, sample size, mathematics topic covered, type of instrument used, statistical method used, results of analysis and significance of test. Statistical transformation and effect sizes were used in answering the research questions while Winer combined test approach was employed in testing the formulated hypothesis. In order to obtain how, large, medium or small the effect size is, the effect sizes

obtained were analyzed and categorized based on Cohen's [2] guideline. That is Effect size (d) ≤ 0.2 – small, $0.2 < d \leq 0.5$ – medium, $0.5 < d \leq 0.8$ – large

Table 1. Summary of the results of previous studies on effect of cooperative learning method on students' academic achievement in mathematics

No of studies based on type of publication		No of studies based on statistical method used		No of studies based on significance of test			
				Significant		Non-significant	
				No	%	No	%
Journal article	15	Means & standard dev.	3	42	92.33	3	6.67
Ph. D	9	ANOVA	2				
M. Ed	21	ANCOVA	33				
		t-test	7				
Total	45		45				

Table 1 shows that out of the 45 studies identified, 15 studies were published articles in journals and conference procedures, 9 studies were Ph.D thesis and 21 studies were M.Ed thesis. Table 1 also shows that out of the 45 studies examined under achievement, the result of 3 studies were reported using means and standard deviations, the result of 2 studies were reported using one way ANOVA, 33 studies were reported using ANCOVA while 7 studies were reported using t-test. The resultant F-ratios, t-ratios, means and standard deviation values were converted to effect size using appropriate statistical methods. On the significance of the test, the table shows that 42 (92.33%) of the studies yielded results that are statistically significant while 3(6.67%) of the studies yielded results that were not statistically significant.

Table 2. Effect sizes associated with all the studies on effect of cooperative learning on students' achievement in mathematics

Study No	**Statistic**	**Effect size r**	**Z Value of r**	**N**	N-3	Weighted Z
1	t-test	0.1128	0.1133	389	**86**	43.7338
2	t-test	0.659	0.7911	60	57	45.0927
3	One Way ANOVA	0.7369	0.9436	162	159	150.0324
4	ANCOVA	0.7023	0.8718	253	250	217.95
5	ANCOVA	0.3846	0.4055	326	323	130.9765
6	ANCOVA	0.9158	1.5625	160	157	245.3125
7	ANCOVA	0.3502	0.3657	292	289	105.6873
8	t-test	0.0889	0.0892	297	294	26.2248
9	One Way ANOVA	0.1191	0.1197	165	162	19.3914
10	ANCOVA	0.333	0.3462	84	81	28.0422
11	ANCOVA	0.2362	0.2407	246	243	58.4901
12	ANCOVA	0.5914	0.6798	159	156	106.0488
13	ANCOVA	0.2359	0.2405	184	181	43.5305
14	ANCOVA	0.0151	0.0151	221	218	3.2918
15	ANCOVA	0.4181	0.4454	400	397	176.8238
16	ANCOVA	0.5554	0.6261	480	477	298.6497
17	Means and Std Dev	0.6678	0.8068	480	477	384.8436
18	ANCOVA	0.7023	0.8717	253	250	217.925
19	ANCOVA	0.4492	0.4837	180	177	85.6149
20	ANCOVA	0.3427	0.3571	225	222	79.2762
21	ANCOVA	0.773	1.0278	240	237	243.5886
22	ANCOVA	0.7986	1.0949	213	210	229.929
23	ANCOVA	0.5689	0.6459	200	197	127.2423
24	ANCOVA	0.7023	0.8717	253	250	217.925
25	ANCOVA	0.6212	0.7269	168	165	119.9385
26	ANCOVA	0.4433	0.4764	100	97	46.2108
27	ANCOVA	0.7511	0.9755	160	157	153.1535
28	t-test	0.1927	0.1951	270	267	52.0917
29	ANCOVA	0.0871	0.0874	101	98	8.5652
30	ANCOVA	0.3893	0.411	75	72	29.592
31	ANCOVA	0.6307	0.7425	143	140	103.95
32	t-test	0.6467	0.7695	160	157	120.8115
33	ANCOVA	0.8155	1.1433	300	297	339.5601
34	Means and Std Dev	0.3826	0.4042	586	583	235.6486
35	ANCOVA	0.7776	1.0393	287	284	295.1612
36	t-test	0.341	0.3552	40	37	13.1424
37	ANCOVA	0.7018	0.8709	227	224	195.0816
38	ANCOVA	0.5473	0.6145	98	95	58.3775
39	Means and Std Dev	0.5722	0.6508	98	95	61.826
40	ANCOVA	0.8026	1.106	80	77	85.162

41	ANCOVA	0.9745	2.1755	80	77	167.5135
42	t-test	0.1323	0.1331	60	57	7.5867
43	ANCOVA	0.7761	1.0354	286	283	293.0182
44	ANCOVA	0.2803	0.288	253	250	72
45	ANCOVA	0.259	0.265	358	355	94.075
	TOTAL				**9717**	**5838.0889**

6. Results

The results of the statistical analysis of the data obtained are presented in the tables below:

Table 3. Summary of the effect sizes (Table 2) based on the quality of effect size

No of studies based on quality of effect size		**Percentage**
Large	24	53.33
Medium	14	31.11
Small	7	15.56
Total	45	100

Table 2 shows the effect sizes of the 45 individual studies examined which is summarized in table 3. The interpretation of the quality of effect size as large, medium or small were done using the guideline provided by Cohen [2].Table 3 indicates that out of the 45 studies investigated 24 studies representing 53.33% were large effect sizes, 14 (31.11%) were medium effect size and 7 (15.5%) were small effect sizes. This indicates that the results of 24 studies shows great degree of effect, the results of 14 studies shows moderate degree of effect while the results of 7 studies shows small degree of effect between cooperative learning method and students' academic achievement in mathematics.

Table 4. Mean effect size associated with all the studies examined on effect of cooperative learning on students' academic achievement in mathematics

Total No of studies	∑(N -3)	∑weighted z	Average Zr =∑ weighted z / ∑ (N-3)	r value of average z (mean effect size	Percentage r variance ($100r^2$)
45	9717	5838.0889	0.6008	0.54	29.16

Where ∑ = summation, Zr = Average z, r = mean effect size,

N = sample size for each of the studies examined.

From table 4, it is observed that the mean effect size associated with cooperative learning is 0.54 which represents a large effect. This implies that the mean magnitude of effect between cooperative learning method and students' academic achievement is high, positive and significant. The table also shows that the percentage variance of students' academic achievement in mathematics attributable to cooperative learning is 29.16%.

Table 5. Winer combined test for all the studies examined on cooperative learning method and achievement in mathematics

∑t	∑ (df/df-2)	z calculated	z – critical
1,107.9473	45.6057	164.0626	1.96

Note ∑t = sum of values of the t-ratio, df = degree of freedom.

From table 5 the calculated z-value is 164.0626 while the critical value of z at 0.05 levels of significance is 1.96. The calculated value is greater than the critical value. This implies that the null hypothesis is rejected. It therefore means that the overall effect of cooperative learning method on students' academic achievement in mathematics is significant.

7. Discussion of Findings

Forty five (45) studies on the effect of cooperative learning method on students' achievement in mathematics were examined in this meta-analysis. The results of the 45 studies yielded a total of 45 effect sizes. The 45 studies in table 1 comprised of 15 journal articles, 9 Ph. D theses and 21 master's degree theses. It was found out from the results that 93.33% of the findings of the primary researchers were positive and statistically significant while 6.67% were statistically non significant. This indicates that greater percentage of the findings is statistically significant. This implies that cooperative learning method has positive significant effect on students' academic achievement in mathematics in Nigeria. This is in agreement with the findings of Onabanjo, Olusoji, Mohammed, Okafor, Nwoke & Nnaji and Okigbo & Ugwu, who found that their different cooperative learning methods have positive significant effect on students' academic achievement in mathematics [7] [9] [10] [11] [12] [13].

The effect size for each study as x-rayed in table 2 showed that there is a variation in the effect sizes associated with the studies examined. The effect sizes ranged from 0.0151 (smallest) to 0.9745 (largest). The results from table 3 showed that 24 (53.33%) of the studies are large effect sizes, 14 (31.11%) are medium effect sizes and 7 (15.56%) are small effect sizes. This indicates that the magnitude of effect is high for 24 studies, moderate for 14 studies and small for 7 studies.

The mean effect size associated with the 45 studies examined as presented in table 4 is 0.54 which

represent a high effect size. This is supported by the analysis of test of hypothesis in table 5 which showed that the overall mean effect of cooperative learning method on students' achievement in mathematics is significant. This result conforms to the findings of Ovute whose meta-analytic result showed that there is positive significant effect of discovery method of teaching on students' achievement in physics [15]. It also agrees with Jacobse & Harskamp who reported that their meta-analysis of the effect of instructional intervention on students' mathematics achievement indicated a statistically significant positive high effect (Cohen's d = 0.58) [6]. This result also supports the meta-analysis study carried out by Mustafa who reported positive significant effect of computer assisted instruction in science and mathematics teaching [8]. However, this result contradicts the finding of Ugbaja who did meta-analysis on the effect of instructional methods on students' achievement in science subjects and reported small mean effect of instructional method on students' achievement in science [19].

8. Conclusion and Recommendation

From the results of the analysis, it could be observed that the results of the previous primary studies shows that cooperative learning method generally have a positive statistically significant effect on students' academic achievement in mathematics in Nigeria. The computed mean effect size indicates that the strength of the effect in students' achievement is also high.

Based on the findings of this study, the following recommendations are made

- The serving mathematics teachers in secondary schools should adopt the cooperative learning method in their mathematics instruction for higher achievement.
- Government and other relevant professional organizations should organize in-service training for serving teachers on how to use cooperative learning method effectively.
- The students in the school of education (i.e. would be teachers) in tertiary institutions in Nigeria should be exposed and trained in line with the use of cooperative learning methods in teaching mathematics in their mathematics method classes. This will help them to master this method and apply it when they graduate and get employed as teachers of mathematics.

9. References

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