THE PLACE OF GEOMETRIC MANIPULATIVES IN SECONDARY SCHOOL MATHEMATICS IN A DEMOCRATIC NIGERIA

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Abstract

Democracy does not thrive on illiteracy. A democratic Nigeria needs a sound and sustainable educational system. The present persistent low mathematics achievement in Nigerian secondary schools is not helping our nascent democracy. Many have cried out openly about the need to stem this perilous tide of frustrating failure in secondary school mathematics. To address the issue, a research was carried out in Edo State, Nigeria. Sixty-six students in Ebelle Secondary School, Ebelle formed the research sample. All students in the sample were in junior secondary school two (JS2) class. Statistical tests revealed a significant difference between the mathematics achievements of students taught with improvised geometric manipulatives and other students. Students taught with manipulatives performed clearly better than students taught without manipulatives.

Introduction

A democratic nation cannot afford to trifle without education. Without a solid educational base, even the best democratic structure is bound to collapse like a house of cards. Mature democratic nations have learnt to place education on their priority list. If the present nascent democracy in Nigeria is to be properly nurtured into a healthy socio-political arrangement, capable of bringing this giant nation into the limelight, we must address major problems facing education. Highlighting one educational problem, Okonjo (2000:42) proposed that.

Teaching and learning must no longer remain the preserve of the 25 per cent of the population, who learn best by listening and reading and assimilate knowledge in a passive manner. Our teaching and learning do have to extend to the 30 per cent of the population, who learn best by listening and seeing and also to the 45 per cent who learn best by listening and doing.

At the secondary school level, mathematics education continues to attract a lot of interest and criticism because of chronic poor performance of our students in mathematics. Ale (2003) used his good offices as the Director and Chief Executive of the National Mathematical Centre, Abuja, to initiate a Mathematics Improvement Programme (MIP). The goal of MIP is to raise mathematics achievement in our schools from the present poor level to a level that will satisfy local and global standards. Ivowi (1997), Ibrahim (1999), Amazigo (2000), Animalu (2000) and Aborisade (2001) are among many personalities who have shown serious concern about the persistent poor achievement in mathematics by secondary school students in Nigeria. They all expressed a strong desire for improvement. Combating poor achievement in mathematics is not new. According to Ale (1989), the Mathematical Association of Nigeria (MAN) titled its silver jubilee conference of 1989, "War Against Poor Achievement in Mathematics (WAPAM)." So, for over a decade, a nationwide reaction against poor achievement in mathematics has been in existence.

As a contribution to WAPAM, a research study was carried out to test the impact of simple geometric manipulatives on the teaching and learning of mathematics in secondary schools. The significance of this study hinges on the simplicity, availability and efficacy of the geometric manipulatives utilized in carrying out the study. If simple nianipidatives, made from ordinary cheap cardboard paper, can prove effective enough to bring about much needed improvement in mathematics achievement, we can use them extensively to help our young ones in schools. That is the focus of this research study.

Research Question

One research question was used in this study:

To what extent does the use of simple, improvised geometric manipulatives improve achievement in mathematics?

Hypothesis

The following hypothesis was tested:

There is no significant difference in the mathematics achievement of students taught with geometric manipulatives and students taught without geometric manipulatives.

Methodology

Methodology has the following subheadings; Research Design, Population, Sample. Instrument, Data Collection and Analysis.

Research Design

The research is quasi-experimental with a simple factorial design aimed at comparing two teaching strategies - teaching with geometric manipulatives and teaching without using manipulatives.

Population

The population for this research study consists of all the students in 19 secondary schools in Esan Central Local Government Area in Edo State.

Sample

Using a table of random numbers, one school was selected out of nineteen in Esan Central Local Government Area in Edo State. The school chosen was Ebelle Secondary School, Ebelle. Junior Secondary School 2, (JS2) was chosen by simple ballot from six possibilities. JSI, JS2, JS3. SSI, SS2, SS3. By another simple ballot, JS2A (34 students) became the control group while JS2B (32 students) was the experimental group, giving a total sample of 66 students.

Instrument

The instrument used for both pre-test and post-test w'as Mathematics Achievement Test (MAT) which was objective type with 28 questions, each with five alternative answers A to E with only one correct answer. MAT had two versions. The second version was simply a reshuffle of the first version with numbers as well as alternative answers of the objective test changed. For example,
IA in the first version could become 17C in the second version. Constructing MAT involved planning the test, using a table of specifications; item writing, face and content validation, item analysis, and evaluating reliability. From thirty-four test items at the planning stage, six items were dropped after validation and item analysis, finally leaving twenty-eight items. MAT was then ready to be given to students. Applying Kuder-Richardson Formula (KR21), the internal consistency reliability coefficient was calculated to be .79. This was high enough to consider MAT reliable as far as internal consistency was concerned. After two weeks, MAT was again administered. After using Pearson's product moment correlation method, the test-retest reliability coefficient was 82. This was high enough to guarantee consistency, over time, of the students' scores on the test items. Treatment instrument consisted of improvised geometric manipulatives with 18 different shapes; equilateral triangle, isosceles triangle, right-angled triangle, scalene triangle, square, rhombus, rectangle, parallelogram, trapezium, kite, pentagon, hexagon, circle, semi-circle, cube, cuboid, prism, and cylinder.

Data Collection and Analysis

To collect the required data. Mathematics Achievement Test, MAT, was given to all the research subjects, consisting of students in JS2A and JS2B. This was the pre-test. After the pre-test, teaching was carried out for ten weeks, with experimental group (JS2B class) being taught with geometric manipulatives while the control group (JS2A class) was taught in the traditional manner, without using manipulatives. At the end of the teaching period of ten weeks, MAT was again administered as post-test. To reduce the risk of obtaining false scores by students copying from neighbours, care was taken to distribute the two versions of the test in such a way that each student is completely surrounded by students with a different version. Table 1 shows the arrangement of MAT in a checkerboard (or draught board) manner. In this type of arrangement, it is important that the writing desks are separated far enough to make sure that students do not cheat by copying diagonally from those writing the same version of test.

Table 1: Checkerboard Arrangement for Testing Students

1 2	1 2	1 2	1 2
2 1	2 1	2 1	2 1
1 2	1 2	1 2	1 2
2 1	2 1	2 1	2 1
1 2	1 2	1 2	1 2
2 1	2 1	2 1	2 1
1 2	1 2	1 2	1 2

1. First Version Test 2: Second Version Test.

Apart from checkerboard arrangement for testing students, another precaution came into this research. Each student did different versions of MAT for pre-test and post-test. A student who had first version for pre-test was given second version for post-test. ' Similarly, all those who answered second version for pre-test, were given first version for their post-test. The pre-test and post-test scores were analysed on the basis of teaching strategy with experimental group using geometric manipulatives, and control group not making use of manipulatives during the ten-week teaching duration.

Findings and Discussions

Table 2: z-test Analysis of Pre-test Scores of Experimental Group and Control Group

Group	**Number**	**Mean**	**Standard Deviation**	**df**	**Calculate d z Value**	**Critical z Value**	**Decision**
Experimental (JS2B)	32	8.63	4.19	65	0.02*	1.96	Difference Not Significant
Control (JS2A)	34	8.65	3.20				

Not significant at .05 level

Table 2 and table 3 refer to z-test analysis of all the scores obtained from the pre-test and post-test of the experimental subjects. From table 2, the mean pre-test score of the experimental group was 8.63, while 8.65 was the mean pre-test score of the control group. With calculated z-value (0.02) within the range of table values (±1.96) at the .05 level of significance, there is no significant difference between the mathematics achievement of the experimental group and the control group. Therefore, the experimental group and the control group were equally matched, academically, at the beginning of the research study.

Table 3: z-test Analysis of Pre-test Scores of Experimental Group and Control Group

Group	Number	Mean	Standard Deviation	df	Calculate d z Value	Critical z Value	Decision
Experimental (JS2B)	32	13.59	5.70	65	2.91*	1.96	Difference is Significant. Reject Flypothesis
Control (JS2A)	34	9.97	4.29				

* Significant at .05 level.

Moving to table 3. experimental group achieved a mean score of 13.59 from post-test scores while the mean post-test score of the control group was 9.97. The calculated z value (2.91) is outside the range of table values of + 1.96 at .05 level of significance. Therefore, the difference between the post-test mean scores of the experimental and control group was significant at the .05 level. This leads to the rejection of the null hypothesis that "there is no significant difference in the mathematics achievement of students taught with geometric manipulatives and students taught without manipulatives." A significant difference *does* exist between the mathematics achievements of the two groups. Analysis of covariance table (Table4) with pre-test as covariates confirms the significant difference between the achievements of students using geometric manipulatives and other students.

Table 4: Analysis of Covariance of Pre-test and Post-test Scores o! "Students

	Sum of Squares	df	Mean	F
POST-TEST Covariates PRE-TES T	1337.738	I	1337.738	306.517
Main Effects GROUP	219.658	1	219.658	50.331*
Model	1554.139 '	2	777.070	178.051
Residual	274.952	63	4.364	
Total	1829.091	65	28.140	

*Significant at .05 levels.

The experimental group had a mean score (8.63) slightly lower than the mean score (8.65) of the control group at the beginning. In the end, the experimental group beat the control group with a much higher mean score. The difference lies in the use of geometric manipulatives for teaching only the experimental group.

Conclusion

The conclusion is that simple improvised geometric manipulatives are effective enough in teaching and learning to bring about better academic achievement in secondary school mathematics. By their nature, simple manipulatives can popularize mathematics. After all, "Math is ... for all of us. When you shop, decorate your home, or listen to the daily weather report, you are using or benefiting from mathematical principles" [Awake! (2003)].

Recommendations

The major recommendations from this research are as follows: -

1) Government should look seriously into the ways our children are taught mathematics in secondary schools, and try to improve them by encouraging the use of appropriate instructional materials, including geometric manipulatives.
2) Our secondary school curriculum should stress the use of instructional materials in teaching mathematics.
3) Seminars, workshops, and inspection tours should be organised to make sure that instructional materials are being adequately utilised in our secondary schools.
4) Parents and teachers should help our secondary school students acquire and use a reasonable quantity of inexpensive mathematics instructional materials, including improvised geometric manipulatives.

This should lead to the much-needed improvement in mathematics achievement in Nigerian secondary schools.

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