Research Journal of Mathematics and Statistic 2(3): 101-104, 2010
ISSN: 2040-7505

Submitted Date: May 28, 2010 Accepted Date: July 01, 2010 Published Date: September 30, 2010

Dienes Multibase Blocks' Approach an Effective Strategy for Improving Students' Interest in Number Bases among Secondary School Students in Mathematics

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Abstract: This study was designed to investigate the effect of Dienes Blocks' Approach on students' interest in number bases. The study adopted non-equivalent control group quasi experimental design. The population of the study comprised all the JSS 3 students in all the junior secondary schools in Makurdi Metropolis in Benue State of Nigeria while the actual sample was 200 students from four single sex secondary schools. The instrument for data collection was Mathematics Interest Inventory on Number Bases (MIIONB), which was developed by the researchers. The reliability of MIIONB was established using Kudder-Richardson Formula 20(K-R_{20}) technique, which yielded a coefficient of 0.72. Mean was used to answer the research questions while ANCOVA was used to test the hypotheses. The result of the study showed that Dienes Blocks' Approach significantly enhanced students' interest in number bases ($F_{1, 199}$= 71.499, $p<0.05$) where as gender was not a significant factor in students' interest in number bases ($F_{1, 199}$ = 0.020, $p>0.05$) even with the use of Dienes Block Approach. Similarly, there was significant interaction effect between method and gender on students' interest in number bases ($F_{1,199}$ = 4.820, $p<0.05$). The study recommended that mathematics teachers should teach mathematics concepts especially the abstract concepts using activity-based approach like Dienes Blocks' Approach.

Key words: Abstract concepts, Dienes' block, Dienes' block approach, mathematics interest, mathematics teaching, number bases

INTRODUCTION

The teaching and learning of mathematics has been one of the sources of problems to the students of Nigeria for a couple of decades now. Available records and recent research findings have displayed the abysmal mathematics performance of students in West African School Certificate Examination (WASCE), Senior Secondary Certificate Examination (SSCE), National Examination Certificate Organization (NECO) and Joint Admission and Matriculation Board -JAMB (Kurumeh, 2008; Obodo, 2004; Bajah, 2003). The number of students who come out successfully each year with credit and above in mathematics had always been less than 50%. This deplorable state of mathematics in terms of students' performance worries all and sundry especially mathematics educators and all stakeholders of mathematics education in Nigeria. Researchers have discovered a number of factors responsible for this abysmal mathematics performance among which is the use of inappropriate teaching methods by mathematics teachers in presenting mathematics concepts and topics to the students and students' lack of interest in mathematics. With such inappropriate methods and students' lack of interest (Oyetunde, 2004), students neither understood the basic principles, the facts nor ideas behind the mathematical topics or concepts. Chief Examiners of WAEC (2006) and National Council of Mathematics Teachers (NCTM, 2000) have recommended the use of effective instructional methodologies that involve practical, Child-centredness, students'- friendly, manipulative and representations in mathematics teaching and learning process, which are capable of arousing students' interest thereby improving their performance (Eze, 1983).

Diene's multibased block approach is a practical, learner-centred, minds-on and hands-on innovative method of teaching especially difficult concepts in mathematics. It is a cognitive approach to meaningful mathematics instruction (Diana and Hilbert, 1988). This was invented by a 20th Century renowned Hungarian mathematician called Zoltan Paul Dienes. He devised this approach to demystify the learning of mathematical concepts especially by the youths. He believes that the teaching of mathematical concepts should be approached through physical or practical means so that the child's

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mind is taken from mere association to complete generalization thereby easing out the abstractness found in mathematics. He designed an apparatus (box) called Dienes' Block for teaching arithmetic in various forms like number bases, place values, arithmetic operations, decimal fractions, basic algebra, etc. It is a type of manipulative but made of cubes/units.

Some studies which tested the contention of the facilitative effect of Dienes' Block Approach have produced positive findings. For instance, in engaging a sample of junior secondary students, Obodo (2004) found that the experimental classes, which received instruction using Dienes' Block Approach demonstrated superiority over control group in the posttest scores. Thompsen (1994) also found that Dienes' Block Approach improved significantly eight grade students' achievement and interest in decimal fractions.

Experience has shown that mathematics teachers in this study area keep using the traditional approach without variation in instructional techniques. It is not clear if the adoption of activity–based approach like Dienes' Bloch approach could arouse and facilitate students' interest and hence lead to improved performance in mathematics. If activity-based approach of teaching can be shown to impact mathematics achievement and interest, this could suggest an effective and alternative method of teaching to enhance achievement and interest, especially in number bases.

The purpose of this study is to determine the effect of Dienes' Block Approach on students' interest in number bases and to equally ascertain if gender difference exists in the mean interest scores of students taught number bases using Dienes' Block Approach

Research questions:
The following research questions guided the study;

- What is the relative effect of Dienes' Block approach and conventional teaching method on students' interest in number bases?
- What is the differential effect of gender on the mean interest scores of students taught number bases using Dienes Block approach?

Research hypotheses: The following null hypotheses were formulated to be tested at $p<0.05$ to guide the Study:

$Ho_{1:}$ There is no significant difference between the mean interest scores of the Experimental group and those of the Control group in number bases

$Ho_{2:}$ There is no significant difference in the mean interest scores of male and female students taught number bases using Dienes' Block approach

$Ho_{3:}$ Teaching method does not interact significantly with gender to influence students' mean interest in number bases.

MATERIALS AND METHODS

This study was conducted in May, 2009. The sample consisted of 200 JSS 3 students randomly selected from four intact classes, sampled from four single sex junior secondary schools in Makurdi Metropolis of Benue State in Nigeria. Single sex schools were used to avoid interferences between boys and girls, as gender was a variable in the study. It is quasi-experiment study, employing Pre-test, Post-test control group design. Intact classes were randomly assigned to the experimental and the control groups respectively.

The instrument used for the study was Mathematics interest inventory on Number Bases (MIIONB) developed specifically by the researchers for this study. The MIIONB comprised of 21 items. This was constructed based on number bases as contained in JSS 3 scheme. Lesson plans were prepared and used for the two groups; treatment and control. The lesson plans in each case reflected the instructional pattern mapped out for use. The lesson notes served as models for teachers' use for the treatment groups.

The face and content validation of this instrument and lesson plans were established by three experts in mathematics education and measurement and evaluation. After modification using their comments, corrections and suggestions, 21 out of 30 items constituted the final instrument for data collection. The reliability of instrument was established using Kuder-Richardson Formula 20 ($K\text{-}R_{20}$), which yielded a coefficient of 0.72, which indicated good internal consistency (Pallant, 2001).

Prior to the study, a training programme was organized for the four regular mathematics teachers who were used as research assistants for the study. They were all graduates of mathematics education selected from the schools already mapped out for the study. Those for the experimental group were exposed for two days on the rudiments of Dienes' Block approach and on the essence of the study. The lesson plans for the study was properly explained to them and they were advised to adhere strictly to the content and rudiments of this approach for a reliable result. At the end of the programme, an informal assessment was given to ascertain the extent of understanding of their job as research assistants for this study.

Dienes' Block consists of a block of 1000 unit cubes. This block comprises of unit, long, flat (square), block and groups of blocks as the case may be. A unit is a cube of $2\times2\times2$ cm^3 in dimension. A long (line) contains some cubes depending on the base, for-example base 3. A flat square contains 9 cubes and a block contains 27 cubes (Obodo, 2004). Dienes' Block is applied using base10 but can be easily decomposed into other bases. The relationship between unit-line-square-block is based on the idea of place value and its significance. This block is used in solving problems involving conversions and

Table 1: Mean and standard deviation of students' Interest in Number Bases

Treatment	Type of test	Gender	N	Mean	SD
Control Group	Post-test	Male	50	45.32	11.58
		Female	50	41.76	12.53
		Total	100	43.54	12.13
Experimental Group	Post-test	Male	49	61.33	11.52
		Female	50	64.76	10.16
		Total	99	63.06	10.93

Table 2: Analysis of Co-variance (ANCOVA) by method and gender

Source	Sum of squares	df	MS	F-test	Sig.	Decision
Model	19879.378	5	3975.876	30.396	.000	S
Intercept	35399.125	1	35399.125	1270.631	.000	S
Pretest	306.319	1	306.319	2.342	.128	NS
Methods	18704.401	2	9352.200	71.499	.002	S
Gender	2.603	1	2.603	.020	.088	NS
Interaction	630.447	1	630.447	4.820	.029	S
Error	25375.577	194	130.802			
Total	612687.000	200				
Corrected Total	452524.955	199				

Note that S means significant and NS means not significant

mathematical operations of plus, minus, multiplication, division and number bases practically. Its practical activities could make solving problems in number bases very interesting, fascinating, fun, pleasurable and involving.

Before the commencement of the treatment, all students were given pre-test using MIIONB. The study lasted for four weeks using the normal school period of 40 min. The experimental groups were taught number bases using Dienes' Block approach while the control groups were taught the same topics using the conventional or traditional method by their regular mathematics teachers.

At the end of the four weeks set out for the study, the same instrument was administered as Post-MIIONB to all the students by the research assistants. However, the post-MIIONB was a restructured version of the pre-MIIONB. The scripts were collected, marked and scored by the researchers and taken for further analysis.

Data analysis: Each research question and the corresponding hypothesis are taken together. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at $p<0.05$. Pre-MIIONB scores were used as covariates, thus serving to adjust for the initial differences between and within groups.

RESULTS

Data for answering research questions 1 and 2 as well as for testing hypotheses 1and 2 are contained in Table 1 and 2, respectively.

It is observed that the students in the experimental group had a higher mean interest score (63.06) than their counterpart in the Control group (43.54) in post –MIIONB.

The males in the control group had a higher mean interest score of 45.32 against the females (41.76) in the post-MIIONB. The experimental group (taught with Dienes Blocks' approach), favoured the females with the mean interest score of 64.76 while males had the mean interest score of 61.33 in the post-MIIONB.

Table 2 shows that the exact probability of the significance of the effect of Dienes Blocks' approach was less than the 0.05 level of significance. The decision therefore was to reject the null hypothesis in favour of the alternative. Therefore, it was concluded that there is significant difference in the mean interest scores between those taught number bases using Dienes Blocks' approach and those taught using conventional method ($F_{1, 199}$ = 71.499, $p<0.05$). This suggests that the experimental group had higher interest resulting in better performance than the control group. Hence, Dienes Blocks' approach proved superior to convectional instructional approach in facilitating interest among students.

It was observed too that the female students had higher mean interest score than their male counterparts in the post-MIIONB using Dienes Blocks' approach with a difference of 3.43 (Table 1). But this difference was not statistically significant as seen in Table 2 ($F_{1, 199}$ = 0.020, $p>0.05$). Therefore, the null hypothesis of no difference was not rejected rather it was retained. But, interaction effect of method and gender on students' interest was significant in Table 2 ($F_{1, 199}$ = 4.820, $p<0.05$). Therefore, the null hypothesis was rejected, that is, there is significant interaction effect of treatment and gender on students' interest in number bases.

DISCUSSION

The results of this study show that Dienes Blocks' Approach has significant effect on students' interest in number bases. The students taught using Dienes Blocks' approach showed higher interest (63.06), which resulted in better performance than the control group taught using the conventional approach with the mean interest score of

43.54. This finding is in line with that of Imoko and Agwagah (2006) who observed that use new approach arouses interest in students due to curiosity. This improved and significant interest must have been as a result of the variety of activities, which characterized Dienes' Approach, where every learner must fully be involved in all fun - like, practical and interesting activities. These hands-on and minds on activities must have empowered and enabled all learners with different characteristic and abilities to benefit greatly from the variety of the learning experiences provided by this approach.

Though there was a difference in the mean interest score of male and female students in favour of the females, the difference was not statistically significant. This agrees with those of Okonkwo (1997) who found that gender is not a significant factor in interest between male and female students in mathematics. This is because Dienes' Blocks' Approach, being activity-based, emphasized on learning experience that will be beneficial to all, male and female alike. It does not therefore discriminate between genders. It ensures that learners irrespective of their gender participated actively in class. Therefore, the students' active participation in the learning process, in the gender balanced classroom environment must have accounted for the superiority of Dienes Blocks' Approach over the conventional method and the no significance with respect to gender. Interaction between method and gender was as well statistically significant.

CONCLUSION AND RECOMMENDATION

From the findings of this study, we can conclude that Dienes Block Approach is effective in improving, enhancing and facilitating students' interest in number bases. This approach too does not discriminate between genders rather it emphasizes on learning experience that will be beneficial to all.

Mathematics teachers are advised to use activity-based methods such as Dienes Blocks' Approach in teaching mathematics concepts especially those concepts that appear abstract. Dienes Blocks' Approach which results in improved cognitive development and acquisition of skills for learning mathematics concepts, could lead to change in students' interest, restoring past glory of improved (positive) achievement in mathematics and solving life problems.

Since students found it easy, interesting and fun, which lead to improved interest, teachers are advised to use Dienes' Approach in teaching mathematics concepts especially number bases to the students.

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