The Use of Graphical Materials in Teaching of Mathematics: Effects on Students' Understanding and Performance

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Abstract

Mathematics teaching and learning process expectedly should portray an interactive and dynamic classroom experience capable of promoting mathematical understanding and sustaining learners' interest in anticipation of applying what they have learnt. This study, being quasi-experimental, therefore expands the empirical base for understanding learners' cognitive load memory capacity in relation to use of graphical materials on students' mastery of mathematics concept of Set Theory. The sample consisted of seventy-five (75) students from the selected schools in Egbeda, Oyo State. Three research hypotheses were tested using t-Test statistics. Evidence from field survey indicates that students were more enthusiastic in classroom because of the interactive nature portrayed by the graphical materials. Results also indicated that students taught with the aid of graphical materials, that is, the experimental group, had significantly higher mean gain score and it was recommended that, teachers should begin the use of graphical materials as opportunity to make the learning of mathematics easier and that, if properly harnessed, this aspect of instruction may serve as simulator helping learners construct meanings and develop their own understanding, ready to take on more complicated structures as they moves towards complex concepts in mathematics.

Key words: *Graphical Materials, Cognitive Load Memory, Performance, Students, Mathematics.*

Introduction

Mathematics is undoubtedly pivotal to science and technological breakthrough that has characterized the 21st century. Bajah and Asim (1995) noted that it is not out of place to state that no technological development can be achieved except mathematical ability is enhanced or developed. In the same vein, Akanmu and Fajemidagba (2013) submitted that mathematics is the backbone of all sciences, while science in turn, is the root of technology and the cornerstone of all fields of studies. The importance and influence of Mathematics to everyday activities in all spheres of life can therefore not be over-emphasized. Most subject areas that involve calculations depends largely on mathematics as precision tool in their search for a clearer understanding of the physical as well as the scientific world. Owing to an increasing availability and usage of technological tools, a progressive phase in the history of mathematics education no doubt has emerged. It is therefore expected that, mathematics teaching and learning process should portray an active, interactive and dynamic classroom experience capable of exploring critical thinking, promoting mathematical understanding and sustaining learners' interest in anticipation of applying what they have learnt. Lim and Kor (2004) documented that in spite of the essential role of teachers, the growing, universal availability of technology tools provides a grand opportunity to assist teachers in teaching well and in improving the mathematics experiences of the students.

Bannert (2002) argued that many cases of reported students' failure of mathematics, are traceable largely to instructional modes characterized by theoretical presentation, an overload of learners' working memory and abstract delivery of the contents to the learners. Thus, as an intervention for better learning and improved performance, there is a need to reduce such abstractive nature in order to make more working memory capacity of the learners for the actual learning. This, the author concluded can be addressed taking into

cognizance the Cognitive Load Theory (CLT) which focuses on the role of instructional modes on the development of learners' working memory.

Specifically, the theory of CLT originated from information processing theory in the 1980s and has undergone substantial modifications and extensions (Sweller, 1988). One major assumption from available studies, is that learners working memory is limited in both capacity and duration. Under such condition, integrating the use of graphical materials should be given consideration.

According to Burill, Allison, Breaux, Kastberg and Aanchez (2002), though handheld graphing technology has been available for nearly two decades, research in the use should be more robust as the use in countries like New Zealand, Netherlands, Sweden, France and United States is still not well understood. In Nigeria, for example, though the widespread of graphing technology is still limited, empirical evidences abounds on the valuable role of graphic materials as organizers (12-Digits Place-value Chart, Four Column Chart, Tally Chart etc) which are perfect for reinforcing key concepts and developing critical-thinking and skills. The focus of this work was to therefore investigate effects of graphic materials on helping students access prior knowledge, organize thoughts and ideas, brainstorm new topics, sequence events, compare and contrast, and visualize relationships. Specifically, Herringbone's graphic organizers (Tiger and Sloth diagram, Dogs and Cats as pets venn diagram, Double venn diagramm) for teaching venn diagram concept in Set Theory was adopted for this study.

Research Questions

Three research questions were raised in this study. They are:

1. What is the effect of the use of graphical materials on students' mastery of mathematics concept of Set theory?

2. Is there any difference in the students' performance on the basis of gender when they are taught using graphical materials to illustrate the concept of Set Theory?
3. Is there a difference in the students' performance on the basis of their scoring levels when they are taught using graphical materials to illustrate the concept of Set Theory?

Research Hypotheses

Based on the research questions, the following hypotheses were generated and tested:

1. There will be no significant difference in post-test mean scores of students taught using graphical materials on mastery of mathematics concept of set theory and those not exposed to graphical materials.
2. There will be no significant difference in post-test mean scores of male and female students in mathematics when they are taught using graphical materials on mastery of mathematics concept of set theory.
3. There is no significant difference in post-test mean scores of students with high, medium and low scoring levels when they are taught using graphical materials on students' mastery of mathematics concept of set theory.

Research Instruments

This study centers on effects of integrating the use of graphical materials in teaching of mathematics on students' understanding and performance. The instructional instruments were Herringbone's graphic organizers (Tiger and Sloth diagram, Dogs and Cats as pets venn diagram, Double venn diagramm) for teaching venn diagram concept in Set Theory for the experimental group while the control group was taught without any graphic organizer. Then Mathematics Achievement Test (MAT) which contained twenty-five multiple choice questions drawn from Senior School Certificate Mathematics past examinations questions conducted by West African Examination Council being already validated and standardized.

Results

Three hypotheses were tested using two-sample t-Test statistics with unequal variances. Hypothesis one and two focused on two variables (experimental and control: males and females) while hypothesis three was splited for the purpose of comparison of scoring levels across the groups, that is, the mean score of high scorers in the control group was compared to that of high scorers in the experimental group. This was repeated for both medium and low scorers in the two groups.

HO_1: There will be no significant difference in post-test mean scores of students taught using graphical materials on mastery of mathematics concept of set theory and those not exposed to graphical materials.

Table 1 indicates that the mean score difference of 2.31 between the experimental group (25.03) and the control group (22.72) was significant at p = 0.01 with t-value of 2.61. This implies that the 99% of the observable variation was not due to luck but the treatment factor. Thus, the null hypothesis was rejected and the alternative hypothesis that there would be a significant difference in post-test mean scores of students taught using graphical materials and those taught without the use of graphical materials was upheld. This is in favour of those exposed to graphical materials.

Table 1:

The t-Test Analysis showing the difference in the mean gain scores of students taught using graphical materials and those not exposed to graphical materials

Variables	No	Means	Std	t-value	Welch's df	p-value
Experimental	**32**	**25.03**	**7.45**	**2.61**	**53.10**	**0.01**
Control	**43**	**22.72**				

Source: Field Survey, 2014

HO_2. There will be no significant difference in post-test mean scores of male and female students in mathematics when they are taught using graphical materials on mastery of mathematics concept of set theory.

Table 2 indicates that there is no significant difference in the performance of male students when compared to their female counterparts particularly on the administration of the treatment. This implies that male and female students performed equally. Hence, the null hypothesis there will be no significant difference in post-test mean scores of male and female students in mathematics when they are taught using graphical materials on mastery of mathematics concept of set theory was upheld.

Table 2

The t-Test Analysis showing the post-test mean gain scores of male and female students in mathematics when taught using graphical materials on mastery of mathematics concept of Set theory

Variables	No	Means	Std	t-value	Welch's df	p-value
Male	19	25.11	1.91	0.07	29.71	0.9
Female	13	24.92				

HO_3: There is no significant difference in post-test mean scores of students with high, medium and low scoring level when they are taught using graphical materials on students' mastery of mathematics concept of set theory.

Tables 3, 4, and 5 indicates that across board in the categorization of students as low, medium and high scorers, there is no significant difference in the performance of the students irrespective of the treatment subjected to. In table 3, the mean score difference of 0.75

between the control and experimental group; in table 4, the mean score difference of 1.14 between the experimental and control group and in table 5, the mean score difference of 1.15 between control and experimental group were not significant at p = 0.88, 0.67 and 0.6401 with t-value of 0.15, 0.43 and 0.47 respectively

Table 3:

The t-Test Analysis showing the difference between Low Scoring Students of Both Control And Experimental Group

Variables	No	Means	Std	t-value	Welch's df	p-value
LS (Exp)	04	28.25	2.29	0.15	4.32	0.88
LS (Cont)	03	29.00				

KEY: LS- Low Scorers

Table 4:

The t-Test Analysis showing the difference between Medium Scoring Students of Both Control And Experimental Group

Variables	No	Means	Std	t-value	Welch's df	p-value
MS (Exp)	21	59.09	8.7	0.43	43.64	0.67
MS (Cont)	23	57.96				

KEY: MS- Medium Scorers

Table 5:

The t-Test Analysis showing the difference between High Scoring Students of Both Control And Experimental Group

Variables	No	Means	Std	t-value	Welch's df	p-value
HS (Exp)	07	77.14	5.11	0.47	15.71	0.64
HS (Cont)	17	78.29				

Summary of Findings

Based on the field survey and data analyzed, it can be deduced that overall performance of students exposed to graphical material was significantly better that their counterpart not exposed to same treatment. There is evidence to suggests that the improvement was largely due to treatment factor. Evidence from field survey indicates that students were more enthusiastic in learning the concept of set theory because of the interactive and dynamic nature portrayed by the graphical materials. Hence, the following are the summary of major findings in this study:

(i) that students exposed to teaching-learning process with the aid of graphical materials, that is, the experimental group, had significantly higher mean gain score;

(ii) that gender has no influence on the performance of the students in spite of the treatment they were subjected to; and,

(iii) that across board, irrespective of the categorization of the students into scoring levels (high, medium and low), the performance was not significantly different.

Discussion

Empirical evidence shown from testing of hypothesis 1 (table 1) indicates that graphical materials are capable of sustaining learners' interest with improved academic

performance because learners were able to develop their own understanding. Available students academic records prior the treatment revealed that students performance was still at low ebb and that the statistically significant difference was not due to luck but an indicator of the potency of the treatment. This position lend credence to the finding of Cavanagh and Mitchelmore (2003) when they found that teachers consistently failed to draw the students attention to limitless power of technology. Their study however showed that students who participated in the study quickly became competent at using the output of the calculator to solve mathematical tasks, their performance compared to pre- exposure to graphic calculator improved drastically. Future use of graphical materials as enhancer was therefore advocated. The results of the present study also support the findings of Nor'ain, Rohani, Wan Zah and Moh'd (2011) which provide evidence of pedagogical impact of the use of graphic calculator as a tool in teaching and learning of mathematics in Malaysia.

Recommendations

An important issue made clear in this study is the need to integrate the use of graphical materials as enhancer in the teaching and learning of mathematics. This aspect of instruction, if properly harnessed, may serve as simulator and a s a result learners will be ready to select, construct meanings and develop their own understanding, ready to take on more complicated structures as they moves towards complex concepts in mathematics. Though the widespread of graphing technology is still limited, with this empirical evidence, it is recommended that teachers should begin the use of graphical materials as opportunity to make the learning of mathematics easier, interactive and capable of sustaining learners' interest in anticipation of applying what they have learnt.

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