Effect of the Use of Graphic Materials in Instructional Delivery on Students' Achievement in Mathematics in Onitsha Education Zone

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Abstract

The study examined the effect of the use of graphic materials in instructional delivery on students' achievement in mathematics in Onitsha Education Zone. Two research questions guided the study and three hypotheses were tested. The quasi-experimental pre-test posttest non-equivalent control group design was used. A sample of 93 SS2 mathematics students were involved in the study. The instrument for data collection was Mathematics Achievement Test (CAT) validated by lecturers in the Department of Science Education with Kuder-Richardson (KR-20) reliability index of 0.79. The data obtained was analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA). The results revealed that there is a significant difference between the mean achievement mathematics scores of students taught using graphic materials and those taught without graphic materials. It was therefore recommended the government through the ministry of education organise seminars and workshop for teachers on how to integrate graphic materials in the teaching and learning process of mathematics.

Keywords: *Graphic materials, Achievement, Mathematics, animations, still pictures*

Introduction

The mode of learning common among secondary school teachers is often structured on traditional chalk-and-talk methods. Despite recent advancements in communication technology, learning at the secondary school level has been highly dependent on time, place and often teacher-oriented. One way to bring about a change of emphasis in teaching, from the teacher directed approach to a facilitated approach, is to change the medium of instruction (Kearsley, 2002). Graphic material offers an alternative medium of instruction to the current learning process. The nature of interactivity and discovery in graphical learning bears a beneficial boost to the monotony of passive learning (Mayer, 2003).

Graphic materials are multimedia elements like coloured images, text, audio or video sequences, and animations (Smiciklas, 2012). Graphic materials can be relevant in teaching various school subjects including mathematics. It involves the use of two or more different types of instructional media in a presentation (Taner, 2016). Supporting this view above, Mayer (2001) noted that an instructional delivery involving the use of VCD/DVD or Power point or 16mm film, for example, is a graphic presentation, in that, still pictures, text, graphics, motion picture, background sound as well as some narrations are synchronized and or combined at the same time in order to enhance learners' understanding of a concepts. Maurice (2008) noted that in this approach, timekeeping and coordination of different media

are involved. It also includes use of interactive elements such as graphics, text, video, sound and animation at the same time to deliver lesson (Nkweke, 2010).

The teacher is expected to use different techniques, methods and media to facilitate learning in the classroom. According to Efebo (1996), when classroom instructions are augmented by examples, questions, demonstrations, and graphical materials, teaching becomes more appropriate. Most graphical material practitioners reflect a cognitive-perceptual philosophy (Bartsch, 2009). They have emphasized the values of synchronizing graphical into learning process as a means of involving several senses of the learner and of combating "verbalism" in the classroom (Aggarwal, 2007). Both teacher and students may control their own pace of lesson according to his or her own ability. Graphic materials according to Parnafes (2007) can give low ability students extensive learning time before moving forward. This aspect of multimedia learning supports student-centred strategy whereby learners take responsibility in their own learning process (Owolabi & Ogini, 2014). The liberty to proceed or recede allows self-pacing (Staylor, 2002), an important facet to enable learners to learn according to their individual pace and that will insure that students may perceive information equally (Kellerman, 2004). Thus, the use of graphic material may bear beneficial boost for abstract subjects that require higher cognitive processing like mathematics.

In the present study, graphic materials were used in the form of projected multimedia instructional presentation. Students were presented with animated text that had background narration of the text displayed on the projection screen. Thereafter, the teacher projected examples of solution relating to problems in linear inequalities and algebraic fractions using the animated texts. On the screen was also displayed, exercises on the lesson objectives to immediate evaluate the students' learning as the lesson proceeded and feedback was used to project from a selected list examples to help the students fully comprehend the mathematical concept. A summary of the lesson was also projected using motion pictures in different colours.

The mathematics curriculum over the years has been delivered mechanically or by rote learning, which makes instruction teacher-centered. Hardly can vital abstract contents in mathematics be effectively communicated to the learners theoretically. They need to be taught using relevant graphical materials that reduce abstraction and bring learning from imaginary world to the realistic world. The teacher and his/her method of teaching is a major source of student's poor academic performance in chemistry as noted in literature. Most teachers still prefer using the 'chalk and talk' method in instructing learners. Although graphical materials could facilitate meaningful learning of biology, it is rarely used, whereas this method is considered as a good strategy for improving cognition (Hoska, 2009). A good deal of expected learning outcomes is not realized in chemistry in our senior secondary schools as a result of non-availability of instructional materials as well as lack of effective utilization of appropriate teaching materials (Nwagbo, 2008). There is need to find out graphical materials will have any effect on the academic achievement of chemistry students. According to Onyegegbu (2006) graphical materials are not only relevant and useful in the context of its use to facilitate learning to achieve a specified and replicable learning outcome, but in enhancing participatory learning when the learners are directly involved in the process of classroom interaction.

Several studies have shown that the use of graphical materials bear beneficial boost on students' achievement in different subject areas. Tatli and Ayas (2013) studied the effect of a Virtual Chemistry Laboratory (VLC) on students' achievement. The results revealed that there was a significant difference between the groups in the post-test at the end of the study.

Scheffe's post-hoc test further revealed that the direction of difference is in favour of the Eexperimental group group suggesting that the graphic materials using in the Virtual Chemistry Laboratory was effective as the real chemistry laboratory. Adegoke (2011) investigated the effect of multimedia instruction on senior secondary school students' achievement in physics. The results showed that, on the average, students in the animation + on-screen text + narration group took best quality notes and this seemed to have influenced their superior cognitive achievement in physics. Generally, students under multimedia instruction performed better than their colleagues in the lecture group, which suggested that learning outcomes of students in physics can be enhanced with multimedia instruction.

Rotimi, Ajogbeje, and Akeju, (2012) conducted a study on a new kind of Visual-model instructional strategy in Physics. The results of the analysis revealed a positive significant effect of treatment on the learning achievement in physics. Yuen-Kuang and Yu-wen (2007) studied the effect of computer simulation (multimedia) on students' learning. The results of this meta-analysis as reported by the researchers indicated that Computer Simulation Instruction has moderately positive effects on students' achievement in comparison with the effects of traditional instruction. The results of the study suggest that the effects of simulations are positive as compared with those of traditional instruction in Taiwan.

The findings of these studies notwithstanding, much is not known about how graphic materials can be applied in teaching mathematic and its effect among secondary school mathematics students is not widely established in literature. The need arose therefore, to further investigate the use of graphic materials in instructional delivery and its effect of achievement of students. Also, the influence of gender on students' achievement in mathematics at the adoption of different instructional strategies is not replete in literature. Thus, studies relating to the influence of gender has on students' achievement in mathematics have been inconclusive. The present study sought also to examine the interaction effect of gender and instructional strategy on achievement of mathematics students.

Objectives of the Study

The study specifically sought to find out the:

1. Difference between the mean achievement scores of students taught mathematics using graphic materials and those taught without graphic material.
2. The influence of gender of students' achievement in mathematics.
3. The interaction effect of instructional strategies and gender on students' achievement in mathematics

Research Questions

1. What is the difference in the mean achievement scores of students' taught mathematics using graphic materials and those taught without graphic material?
2. What is the difference between the achievement scores of male and female students in mathematics?

Hypotheses

1. There is no significant difference in the mean achievement scores of students' taught using graphic materials and those taught without graphic material.
2. There is no significant difference between the achievement scores of male and female students in mathematics.
3. There is no significant interaction effect instructional strategies and gender on students' achievement in mathematics.

Methodology

The design adopted for the study was quasi-experimental. The pretest-posttest non-equivalent control group design was used. The area of the study was Onitsha Education Zone of Anambra State. The population of the study comprised 18, 411 Senior Secondary School year two mathematics students. The sample size for the study was 93 SS2 mathematics students obtained through multi-stage sampling procedure. Random sampling was used to select two local government areas under Onitsha Education Zone. Purposive sampling was used to select one school each from the two selected local government area to take care of gender by selecting only coeducational schools. Random sampling was used to assign the selected schools into experimental and control group and to select one intact class of mathematics students from the schools.

The instrument for data collection was a Mathematics Achievement Test (BAT) consisting of 50 objective questions adopted from Senior Secondary School WAEC (SSWAEC) past question papers on Mathematics (Anyaele, 2016). A table of specification was used to ensure adequate coverage of the content areas (Linear inequalities and algebraic fractions) taught. Lesson packages which integrated graphic materials in the stages of the lesson were developed. The instrument and intervention was validated by two lexperts from the Department of Science Education, Nnamdi Azikiwe University, Awka. The reliability of the MAT was established using the Kudder-Richardson Formula 20 (KR 20). The instrument was administered on 20 Mathematics students in a school not used in the study. The generated scores were computed for reliability using KR-20. The coefficient of internal consistency obtained was 0.79. For the experiment, two regular mathematics teachers from the two schools were briefed. The teachers carried out the treatment exercise under the researchers' close supervision. MAT was administered as pretest before the commencement of the treatment .

The treatment involved the experimental group receiving instruction on the selected mathematics concept with the teacher projecting graphic materials at different steps during the lesson. The control group was exposed to the same content but there was no use of graphic materials. At the end of the treatment exercise, students were administered with a posttest. Their scores in the posttest and pretest were collated for analysis.

The researchers controlled for Hawthorne effect, by using the regular classroom mathematics teachers in the selected school; initial group difference was controlled through the use of analysis of covariance (ANCOVA); and effect of pretest on posttest reduced using different coloured paper and reshuffling of the questions for the posttest. The research questions were analysed using mean and standard deviation and the null hypotheses were tested using analysis of covariance. The decision rule was that the null hypotheses be rejected when P-value is less than 0.05, otherwise, the hypothesis was not rejected.

Results

Research Question 1: What is the difference in the mean achievement scores of students' taught mathematics using graphic materials and those taught without graphic material?

Table 1: Mean achievement scores of students taught using graphic materials and those taught without graphic materials

Groups	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gain in Mean
Experimental	44	24.09	11.06	79.84	4.67	55.75
Control	49	19.90	10.18	49.39	5.64	29.49

Table 1 shows that students taught mathematics using graphic materials has gain in mean achievement scores of 55.75 while those taught without graphic materials has gain in mean

achievement score of 29.49.

Research Question 2: What is the difference between the achievement scores of male and female students in mathematics?

Table 2: Mean achievement scores of male and female students taught using graphic materials

Groups	Gender	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gain in Mean
Experimental	Male	19	23.16	11.08	81.21	4.78	58.05
	Female	25	24.80	11.22	78.80	4.57	54.00
Control	Male	23	20.00	9.17	50.43	4.50	30.43
	Female	26	19.81	11.18	48.46	4.64	28.65

Table 2 shows that male students taught mathematics using graphic materials has gain in mean achievement scores of 58.05 while female students has gain in mean achievement score of 54.00. Table 2 also shows that male students taught mathematics without graphic materials has gain in mean achievement scores of 30.43 while female students has gain in mean achievement score of 28.65.

Testing the hypotheses

Table 4: ANCOVA on Significance of Difference in the mean achievement scores of students taught using graphic materials and those taught without graphic materials

Source	SS	Df	Mean Square	F	Sig.	Decision
Corrected Model	21610.495[a]	4	5402.624	255.797	.000	
Intercept	29360.987	1	29360.987	1390.151	.000	
Pretest	.648	1	.648	.031	.861	
Method	2105.310	1	2105.310	99.680	.000	S
Gender	109.375	1	109.375	5.179	.075	NS
Method * Gender	1.021	1	1.021	.048	.826	NS
Error	1858.624	88	21.121			
Total	401969.000	93				
Corrected Total	23469.118	92				

a. R Squared = .921 (Adjusted R Squared = .917)

Data relating to hypotheses one to three is contained in table 4.

***Ho₁*:** There is no significant difference in the mean achievement scores of students' taught using graphic materials and those taught without graphic material.

Table 4 shows that there was a significant main effect of the treatment on the mean achievement scores of the students, $F(1, 92) = 99.680$, $P < 0.05$. Therefore, null hypothesis was rejected. Thus, there is a significant difference in the mean achievement scores of students' taught using graphic materials and those taught without graphic material in favour of those taught using graphical materials.

***Ho₂*:** There is no significant difference between the achievement scores of male and female students in mathematics.

Table 4 also shows that there was no significant main effect of gender on the mean achievement scores of male and female mathematics students, $F(1, 92) = 5.179$, $P > 0.05$. Therefore, null hypothesis was not rejected. Thus, there is no significant difference between the achievement scores of male and female students in mathematics.

***Ho_3*:** There is no significant interaction effect instructional strategies and gender on students' achievement in mathematics.

Table 4 further shows that there was no significant interaction effect of instructional strategies and gender on the achievement of students in mathematics, F (1, 92) = .048, P > 0.05. Therefore, null hypothesis was not rejected. Thus, there is no significant interaction effect instructional delivery approach and gender on students' achievement in mathematics.

Discussion

The finding of the study revealed that the use of graphic materials significantly enhanced students' achievement scores mathematics. The observed results could be attributed to the fact that graphic materials can have a purely cosmetic function when it is used to make instruction attractive to learners. For example, specially coloured and motion effects of graphic materials sometimes can dazzle and impress students in the opening title of a lesson. The graphic materials could have also helped the teacher to gain sustained attention of the students. Examples of this function include interesting special effects for transitions between instructional frames, screen washes, moving symbols or characters, and animated prompts. It particularly helped to gain the attention of the learners at the beginning of a lesson.

Another reason for the improvement in achievement due to the use of graphic materials is its use as part of the presentation strategy In general, graphical materials can provide a concrete reference for difficult concepts and a visual context for ideas. Since text illustrated with graphics is retained at a higher degree than text alone, one could argue that graphic materials can improve retention of information due to the link between static and dynamic visuals. Even if rote retention is not the goal of education, graphical materials can help present information by defining a concept, rule, or step in a procedure. Graphical materials also can supplement the text by providing examples of or elaborating upon a concept.

The findngs of the study is in line with the findings of Adegoke (2011), Rotimi et al. (2012), Yuen-kuang and Yu-wen (2007) and Tatli and Ayas (2013). The finding of the study is in line with that of George (2008) that graphic organizers improved academic achievement of high school students who received instruction in blended, computer-based learning environment. The finding of the study also supports that of Taner (2016) who reported that the use of infographic improved students' achievement positively and significantly.

Conclusion

The study concluded that the use of graphical materials is effective for improving students' achievement in mathematics and reducing cognitive abstraction inherent in mathematics concepts. The study also establishes that the use of graphical materials reduces gender difference in mathematics achievement.

Recommendations

Based on the findings of the study, the following are recommended:

1. The government through the ministry of education should organize seminars and workshop for mathematics teachers on how to integrate graphic materials in the teaching and learning process of mathematics.
2. School heads should provide graphic materials for their schools to ensure the availability of instructional materials.
3. Graphic designers should seek to develop subjected laden graphic materials for mathematics instructions.

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