Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.6, No.5, 2015

Effects of Graphic Organiser on Students' Achievement in Algebraic Word Problems

Josiah Owolabi[1]* Tobiloba Faith Adaramati [2]
1.Mathematics/Statistics Department, Federal College of Education (Technical), Akoka, P.O Box 269, Yaba, Lagos, Nigeria
2 Federal University of Technology, Minna, Niger State, Nigeria
*E-Mail of the corresponding author : josiahowolabi@yahoo.com

Abstract
This study investigated the effects of graphic organiser and gender on students' academic achievement in algebraic word problem. Three research questions and three null hypotheses were used in guiding this study. Quasi experimental research was employed and Non-equivalent pre and post test design was used. The study involved the Senior Secondary School 2 (SS2) students in Lagos state. The sample comprised of 40 respondents distributed across three treatment groups [13 in Experimental group 1(E_1), 12 in Experimental Group2 (E_2) and 15 in Control group (C)]. The experimental groups were taught using the graphic organiser while the control group was taught using conventional teaching approach. A Word Problem Achievement Test (WPAT) was used to collect data for both the pre and post tests. The WPAT was administered to all 40 respondents in the three groups, first as pre-test and after treatment as post-test. Mean and standard deviations were used to answer the research questions while ANCOVA and multiple comparisons were used in testing the three null hypotheses. The results of the analysis indicated that (i) the experimental groups performed better than the control group (ii) the treatment appeared to be more effective among male students than their female counterparts (iii) the main effect of treatment was significant and (iv) the main effect of gender as well as the interaction effects of treatment and gender were not statistically significant.
Keywords: Graphic organiser, Effects, Gender, Achievement, Conventional, Word Problems.

1. Introduction

Effective teaching is crucial to learning because the products of teaching such as knowledge, skills and attitude acquisition are much dependent on the teacher's effective teaching. Effectiveness of a teacher and students' learning can be enhanced through the appropriate strategy adopted in a learning situation. Recently, there is an increasing awareness of the importance of a learner centred teaching/learning situation and instructional strategies such as interactive boards, projections, models, drama, graphic organiser etc are been integrated into the teaching and learning process.

A Graphic organiser (GO) (one of the many instructional strategies) is a graphical representation of text concepts. It is an instructional tool that can help students to organise information, structure the information and concept to relate with other concepts. They are visual representations or illustrations that depicts relationship among the key concepts involved in a lesson, unit or lesson task (Braselton and Decker, 1994). The history of graphic organisers is rooted in David Ausubel advanced organiser. Ausubel (1968) described the organizer as a tool that bridges the gap between what the learner already know and what they have to learn at any given moment in their educational career. Cognitive psychologists believe that all of a person's prior knowledge is stored in the cognitive structures of the brain. Several cognitive theories in particular lend support to the use of graphic organizers in helping students process and retain information. Schema theory, dual coding theory and cognitive load theory provide the basis for explaining the characteristics of graphic organizers that support the learning process.

According to schema theory, memory is composed of a network of schemas. A schema is a knowledge structure that accompanies or facilitates a mental process. According to Dye (2000), "the graphic organizer has its roots in schema theory". When students learn something new, they must be able to retain the information for later use. Our knowledge is stored in a scaffold hierarchy as a way of organizing information. The teacher's task is to ensure that the students have prior knowledge related to the concept and to provide a means for helping the students make connections between prior knowledge and new concepts. Dual coding theory assumes that memory consists of two separate but interrelated systems for processing information. One system is specialized in processing non-verbal imagery. The processed and stored images are termed imagens (Paivio, 1986). The other is specialized in dealing with language. The resulting stored linguistic information are termed logogens (Paivio, 1986). While each system can be activated independently, there are connections between the systems that allow for the dual coding of information.

The use of graphic organizers also helps students generate linguistic representations. As a visual tool, graphic

organizers help students process and remember content by facilitating the development of imagens. As a linguistic tool, text based graphic organizers also facilitate the development of logogens thereby dual coding the information. Cognitive load is the amount of mental resources necessary for information processing (Adcock, 2000). Cognitive load theory maintains that working memory can deal with a limited amount of information and if its capacity is exceeded, the information is likely to be lost. Visual learning tools such as graphic organizers can reduce the cognitive load and as a result, allow more of the working memory to attend to learning new material (Adcock, 2000). Graphic organisers help meaningful learning in several ways. It is an activity that provides the student with an opportunity to organize, summarize, analyze and evaluate different ideas. Thus, it promotes the development of critical thinking skills, which can then be used for other meaningful learning activities (Sharma, 2012; Kumar Manoj & Rizwaan, 2013; Brinkerhoff & Booth 2013). Graphic organiser templates that are useful and effective for teaching and learning process can be acquired from softwares such as Inspiration, Kidspiration etc,

Studies have shown that effective learning can be assisted through the use of GOs (Ives, 2007); McElory & Coughlin, 2009). DeWispelere Kossak (1996) found that graphic organiser enhanced the critical thinking and higher order thinking skills of the students. The findings of Braselton and Decker (1994); Githua and Nyabwa (2007); Jitendra (2002); Zollman (2006), (2009); Pantziara, Gagatsis, and Elia (2009); Butler, Miller, Crehan, Babbit, & Pierce (2003); Witzel, Mercer, & Miller (2003) showed that graphic organiser resulted in the improvement in achievement or performance in the mathematics problem solving. Also Ives, (2007); Delinda van Garderen (2007); Baxendell, (2003); Gagnon and Manccini, (2000) used of graphic organiser among students with learning disabilities showed that GO helped the students to comprehend the content, organise the information, retain and recall in mathematics as measured by post-tests.

The interaction effect of gender and graphic organiser on students' academic achievement is also studied in literature. Specifically Foxworthy (1995), found that the interaction effect between gender and graphic organiser was not statistically significant. Also studies by Stone (1983) and Mannings (1998) show that the use of GO did not differentiate significantly between the performance of male and female students. The effect of GO on students' academic achievement in mathematics are found to be effective while that of gender and graphic organiser were found to be inconclusive.

A study on the effect of graphic organiser on students' achievement in mathematics especially in Nigeria appears to be scarce. This study therefore sought to find out (i) The main effect of graphic organiser treatment on students' academic achievement in algebraic word problem. (ii) The main effect of graphic organiser treatment on students' academic achievement in algebraic word problem. (iii) The interaction effect of graphic organiser treatment and gender on students' academic achievement in algebraic word problem.

2. Purpose of the study

This research was done to determine the following;

- The extent to which the use of graphic organiser treatment will influence the students' achievement in algebraic word problems.
- To look into the influence of students' gender on their achievement in algebraic word problems.
- The extent to which gender and treatment will interact to improve the students' achievement in algebraic word problems

3. Research Questions

1. What is the pattern of influence of treatment on the students' achievement in algebraic word problems?
2. What is the pattern of influence of gender on students' achievement in algebraic word problems?
3. To what extent has gender and treatment interacted to improve students' achievement in algebraic word problems?

4. Research Hypotheses

The following were tested at alpha level of 0.05

1. Ho_1: There is no significant main effect of treatment on students' achievement in algebraic word problems.
2. Ho_2: There is no significant main effect of gender on students' achievement in algebraic word problems.
3. Ho_3: There is no significant interaction effect of treatment and gender on students' achievement in algebraic word problems.

5. Methodology

The study adapted a pre-test/post-test non-equivalent group control design. Three non-equivalent groups were used as samples for this study.

C	Ya	Cv	Yb
Ea	Ya	X	Yb
Eb	Ya	X	Yb

Where Ya is the pretest
Yb is the post-test
X is the treatment (Graphic organiser)
Cv is the conventional teaching method
C is the control group
Ea is the first experimental group
Eb is the second experimental group

The respondents comprised of 40 Senior Secondary School 2(SS2) students. Purposive sampling technique was used to select the SS2 students at Hebron Land College, Ajegunle-Ikorodu Road, Lagos Nigeria and Simple random sampling was used to select the 40 respondents. The WPAT (Word Problem Achievement Test) was used for data collection.

6. Procedure

The graphic organiser used was designed and prepared by the researcher. The teacher in charge of teaching mathematics in the school used the conventional approach to instruct the respondents while the researcher took the Experimental groups A and B using the graphic organiser instructional strategy. Before treatment, the Word Problem Achievement Test (WPAT) was administered to the respondents of the study as pre-test and the scores served as the covariate in this study. All the respondents were first taught using the conventional method. After this, the Experimental group A was taught using the graphic organiser and was given blank organisers for solving word problem exercises while the Experimental group B was taught how to design one. After the treatment, the WPAT was re-administered and used as a post-test. The pre and post achievement scores in word problems were used to answer the research questions and also to test the hypotheses that guided the study. A summary of the results is presented in the tables below.

7. Results

7.1 Answers to Research Questions

Table 1: Summary of Mean Difference of Students' Academic Achievement by Treatment.

		Pre-test		Post-test		
Treatment	N	Mean	SD	Mean	SD	Mean gain
Control group	15	14.2	4.06	36.3	7.51	22.1
Experimental Group A	13	19.2	7.19	45.7	7.58	26.5
Experimental Group B	12	25.8	9.93	59.5	13.92	33.7

Table 2: Summary of Mean Difference of Students' Academic Achievement by Gender.

		Pre-test		Post-test		
Gender	N	Mean	SD	Mean	SD	Mean Gain
Male (M)	27	19.3	8.37	46.9	13.58	27.6
Female (F)	13	19.4	9.19	45.2	14.10	25.8

Table 3: Summary of Mean Difference of Students' Academic Achievement Across Treatment and Gender

			Pre-Test		Post-Test		
Treatment	Gender	N	Mean	SD	Mean	SD	Mean Gain
Control Group	Male	10	14.1	3.45	37.2	6.92	23.1
	Female	5	14.4	5.55	34.6	9.15	20.2
Experimental Group A	Male	10	19.2	7.69	45.7	8.49	26.5
	Female	3	19.3	6.66	45.7	4.51	26.4
Experimental Group B	Male	7	26.9	9.26	62.3	13.57	35.4
	Female	5	24.4	11.74	55.6	14.96	31.2

From table 1, the students in Experimental group B had the highest mean gain ($\bar{x}$ = 33.7) followed by those under Experimental Group A ($\bar{x}$ = 26.5). Those under the control group had the lowest mean gain ($\bar{x}$ = 22.1).

From table 2 above, the male students who had lower pre-test scores ($\bar{x}$ = 19.3) had a higher mean gain in score in

algebraic word problem ($\bar{x}$ = 27.6) compared to their female counterparts ($\bar{x}$ = 25.8). Both the male and female groups have higher post-test scores (Male = 46.9, Female = 45.2) compared to their pre-test scores (Male = 19.3, Female = 19.4). The implication of this finding is that the male students benefited more from the treatment than the females.

From table 3, the male and female students under the Experimental group B had the highest mean gain ($\bar{x}$ = 35.4 and $\bar{x}$ = 31.2 respectively) followed by the male and female students of experimental group A ($\bar{x}$ = 26.5 and $\bar{x}$ = 26.4 respectively). The male and female students under the control group had the least mean gain ($\bar{x}$ = 23.1 and $\bar{x}$ = 20.2 respectively). The table also show that the male students in the Experimental group B had the highest post-test score ($\bar{x}$ = 62.3) compared to their female counterparts ($\bar{x}$ = 55.6). The male and female students in Experimental group A had the same post-test score ($\bar{x}$ = 45.7). In the control group the male students post test score ($\bar{x}$ = 37.2) was higher than that of their female counterparts ($\bar{x}$ = 34.6). The implication of the above finding is that in Experimental group B, the male students benefited more from the treatment than the females.

7.2 Answers to Research Hypotheses

Table 4: Summary of Analysis of Covariance (ANCOVA) of Post-test mean scores of students' academic achievement

Source	Type III sum of squares	Df	Mean Square	F	Sig.	Partial Eta. Squares
Corrected model	6071.261[a]	6	1011.877	22.070	.000	.851
Intercept	2204.177	1	2204.177	64.100	.000	.674
Pretest	2329.387	1	2329.387	67.741	.000	.686
Treatment	328.363	2	164.182	4.775	.016*	.235
Gender	48.962	1	48.962	1.424	.242 $_{NS}$	.044
Treatment*Gender	20.904	2	10.452	0.304	.740 $_{NS}$	.019
Error	1065.983	32	33.312			
Total	93209.250	40				
Corrected Total	7137.244	39				

a = R. Squared = .807 (Adjusted R squared = .812), * = significant at P < 0.05, NS= Not significant at P < 0.05

Table 5: Scheffe Post Hoc Multiple Comparison of Academic Achievement by Treatment

(i) Treatment	(j) Treatment	Mean difference (I – J)	Std. error	Sig.
Control Group	Experimental group A	-3.049	2.631	.766
	Experimental group B	-10.114*	2.820	.003
Experimental group A	Control Group	3.049	2.631	.766
	Experimental group B	-7.066*	2.674	.038
Experimental group B	Control Group	10.114*	2.820	.003
	Experimental group A	7.066*	2.674	.038

* The mean difference is significant at 0.05 level

Table 6: Scheffe Post Hoc Multiple Comparison of Academic Achievement by Gender

Gender		Mean difference (I – J)	Std. error	Sig.
(I)Gender	(J) Gender			
Male	Female	-.364	2.125	.865
Female	Male	.364	2.125	.865

The result in table 4 indicate that there is a significant main effect of treatment (Graphic organiser) on the students' academic achievement in algebraic word problem {F (4.775) = 0.016, p < 0.05)}. Since the p-value of the F ratio is significant, it follows that Ho_1 which relates to the main effect of treatment on students' academic achievement in algebraic word problem was rejected hence there is a significant main effect of treatment on the mean achievement scores of the students in algebraic word problems. This simply means that the treatment (graphic organiser) improved the performance of the students in algebraic word problem. The partial Eta squared estimated was 0.235, implying that treatment accounts for 23.5% of the variance observed in post-test academic achievement in algebraic

word problems.

The table also showed that the main effect of gender on the students' academic achievement in algebraic word problem is not statistically significant {F (1.424) = 0.246, p > 0.05)}. It therefore follows that hypothesis Ho_2 on the main effect of gender on students' academic achievement in algebraic word problem was accepted. This implies that gender does not have impact on students' academic achievement in algebraic word problem. The partial Eta squared estimated was 0.044, implying that gender accounts for 4.4% of the variance observed in post-test academic achievement in algebraic word problems.

Table 4 also showed that there was no significant interaction between treatment and gender on students' mean achievement in algebraic word problem. {F (0.304) = 0.740, p > 0.05) Hence, the interaction of treatment and gender does not have impact on students' academic achievement in algebraic word problem. The partial Eta squared estimated was 0.019, implying that the interaction of treatment and gender accounts for 1.9% of the variance observed in post-test academic achievement in algebraic word problems.

Table 5 above shows Scheffe Post Hoc multiple comparison of mean scores across treatment groups. The result showed that there is a significant mean score difference between the pairs of Control group and Experimental group B as well as Experimental group A and Experimental group B. Specifically, the mean score of Experimental group B is statistically higher than those of Experimental group A and the Control Group. Table 6, indicates the mean differences of achievement scores of students by gender. The result shows that there is no significant mean score difference between the achievement scores of male and female students of the study.

8. Discussion

The results presented in table 4 showed that the main effect of treatment was statistically significant. This implies that the treatment greatly improved the students' achievement in algebraic word problem. The findings of this study agrees with the findings of other studies (Braselton & Decker (1994); Githua and Nyabwa (2007); Jitendra (2002); Zollman (2006), (2009); Pantziara et al (2009); Butler, Miller, Crehan, Babbit, & Pierce (2003); Witzel, Mercer, & Miller (2003)) in which the use of graphic organiser resulted in an improvement in the students performance in mathematics concepts. The non-significant effect of gender and as well as the interaction of treatment and gender in this study also agree with the findings of (Foxworthy, 1995; Stone, 1983; Manning, 1998) where they found that both male and female students benefited almost equally from the use of graphic organisers in teaching mathematics concepts.

9. Conclusion and Recommendation

The findings of this study indicate that graphic organiser is a more effective approach to learning mathematics when compared to the lecture/ conventional method that has been in use for years. This approach which is not largely used and integrated in teaching and learning process in Nigerian secondary schools was more effective than the old conventional method in improving the students' learning of algebraic word problem. It is therefore recommended that these methods be employed in the teaching and learning of mathematics concepts in Nigeria. Of the two experimental groups, this study also showed that the group that were taught to design graphic organiser (Experimental group B) did better than the first experimental group that used already prepared graphic organiser. Mathematics teachers/instructors are encouraged to use graphic organiser in teaching. To enhance the use of graphic organiser approach in teaching mathematics in Nigerian secondary schools, teachers are encouraged to source for graphic organiser templates and software such as Kidspiration, Inspiration etc. that will assist them in the use of Graphic Organiser in teaching and learning of mathematics.

References

Adcock, A. (2000). Effects of cognitive load on processing and performance. Retrieved January 23, 2005, fromUniversity of Memphis Instructional Media Lab Web site: http://aimlab.memphis.edu/amyscogpaper.pdf

Ausubel, D. P. (1963). The psychology of meaningful verbal learning. New York: Grune & Straton.

Baxendell, B. W. (2003). Consistent, coherent, creative: The three c's of graphic organizers. *TeachingExceptional Children, 35*(3), 46-53.

Braselton, S., & Decker, B. S. (1994). Using graphic organizers to improve the reading of mathematics. *TheReading Teacher*, 48(3), 276 – 281. Retrieved January 5, 2008 from EBSCO online database, Academic Search Premier http:// search.ebscohost.com/login.aspx?direct=true&db=aph&AN=8735219&site=ehost-live

Brinkerhoff L. J.; Booth M. Gary (2013): The Effect of Concept Mapping On Student Achievement in An Introductory Non-Majors Biology Class. *European International Journal of Science and Technology*

ISSN: 2304-9693, 2(8). 43-72.

Butler, F. M., Miller, S. P., Crehan, K., Babbitt, B., & Pierce, T. (2003). Fraction instruction for students with mathematics disabilities: Comparing two teaching sequences. *Learning Disabilities Research & Practice, 18*(2),99-111.

Delinda Van Garderen. (2007). Teaching Students with LD to Solve Mathematical Word Problems. Journal of Learning Disabilities, 40(6), 540-553.

DeWispelaere, C., & Kossack, J. (1996). Improving student higher order thinking skills through the use of graphic organizers. Elk Grove Village, IL: Master's Thesis, Saint Xavier University. (ERIC Document Reproduction Service No. ED400684)

Dye, G. A. (2000). Graphic organizers to the rescue! Helping students link and remember information. *Teaching Exceptional Childre*n, *3*2(3), 72-76.

Foxworthy, D. (1995). The effects of modified graphic organizers on knowledge acquisition and science skills.(Doctoral dissertation, West Virginia University, 1995). Dissertation Abstracts International, 56, 0256.

Gagnon, J.C & Manccini, P. (2000). Best Practices for Teaching Mathematics to Secondary Students with Special Needs. Focus on Exceptional Children, 32(5), 1-22.

Githua, B., & Nyabwa, R. A. (2008). Effects of graphic organiser strategy during instruction on secondary school student's mathematics achievement in Kenya's Nakuru district. *International Journal of Science and Mathematics Education (6)* , pp. 439-457.

Ives, B. (2007). Graphic Organizers Applied to Secondary Algebra Instruction for Students with Learning Disorders. *Learning Disabilities Research & Practice, 22 (2),* 110-118.

Kumar, M. & Rizwaan, M. (2013). Impact of Teaching through Concept mapping on Achievement in Social Studies' Components. *International Indexed & Refereed Research Journal. 4(46). 54-57.*

Jitendra, A. K. (2002). Teaching students math problem-solving through graphic representations. *TeachingExceptional Children*, *34* (4), 34–38.

Manning, L. (1998). Gender differences in young adolescents' mathematics and science achievement. *Childhood Education*, 74, 168-171.

McElroy, L. T., & Coughlin, C. N. (2009). The other side of the story: Using graphic organizer as cognitive learning tools to teach students to construct effective counter-analysis. Unpublished thesis University of Baltimore Law Review.

Pavio, A. (1986). Mental R epresentations . New York: Oxford University Press.

Pantziara, M., Gagatsis, A., & Elia, I. (2009). Using diagram as tools for the solution of non-routine mathematical problems. *Educational Study Math (72)* , pp. 39-60.

Sharma, S. (2012). Effect of Concept Mapping Strategy on the Learning outcome in Relation to Intelligence and study habits. *International Multidisciplinary e -Journal.*1(7): 44-52.

Stone, C. (1983). A Meta-Analysis of Advance Organizer Studies. *Journal of Experimental Education*, 54, 194-199.

Witzel, B., Mercer, C., & Miller, M. D. (2003). Teaching Algebra to students with learning difficulties: An investigation of an explicit instruction model. *Learning Disabilities Research & Practice, 18*(2), 121-131.

Zollman, A (2006) Write is right: Improving students problem solving using GO presented at the 105th annual convention of the school science and mathematics association, Missoula MT.

Zollman A. (2009a). Mathematical graphic organizers. *Teaching Children Mathematics, 16*(4),222-229.

Zollman A. (2009b). Students using graphic organizers to improve problem solving, *Middle School Journal,41*(3), 4-12.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar