EFFECTS OF TWO METACOGNITIVE STRATEGIES ON ACHIEVEMENT OF JUNIOR SECONDARY SCHOOL STUDENTS IN ALGEBRA IN ONITSHA EDUCATION ZONE

Akaeze, Justina Ukamaka & Okigbo, EbeleChinelo
Department of Science Education, Nnamdi Azikiwe University, PMB 5025, Akwa
Jucakeaze@yahoo.comec..okigbo@unizik.edu.ng

Abstract
This study investigated the effect of graphical organizer and metacognitive reading on Junior secondary school two (JSS2) students' academic achievement in algebra in Onitsha Education Zone of Anambra State. One research question guided the study and one null hypothesis were tested at 0.05 alpha level A quasi experimental research design, specifically, pre-test, post-test non-equivalent control design was used. The population of the study consists of 4,433 JSS2 students while 150 students formed the sample size. The sample technique employed was multi-stage sampling. The research instrument used for data collection was the mathematics achievement test. The instrument was validated by three experts and Kuder Richardson Formula 20 was used to ascertain the reliability coefficient at 0.87. Mean, standard deviation and analysis of covariance were used for data analysis. The findings of the study showed that students taught algebra using Graphic Organizer and metacognitive reading strategies significantly achieved more than those taught with traditional method and students taught algebra using graphic organizer achieved significantly higher than those taught using conventional method of teaching. It was recommended among others that in-serving mathematics teachers should be trained by government and ministry of education on the use of graphic organizer and metacognitive reading strategies through workshops, seminars.
Key words: Algebra, Achievement, metacognitive, strategies.

Introduction

Mathematics is one of the core subjects at both the primary and secondary school education system in Nigeria. According to the National Policy on Education (NPE, 2013), Mathematics is a compulsory subject taught at the primary and secondary levels of education in Nigeria. Its function and relevance to education and the society makes it to be regarded as the bedrock of science and technological development. In view of this, Okafor (2015) argued that no nation can develop scientifically and technologically without proper foundation in mathematics.

Mathematics is extensively employed in all areas of life to resolve computation problems. It is a language in which scientific ideas are expressed and the means by which other science subjects including Physics, Chemistry, Biology and disciplines like Engineering, Geology are understood. Mathematics enables the various sciences to draw the implications of their observational and experimental findings. Thus, Mathematics has become so valuable that there is nothing in all human endeavours that does not apply mathematics knowledge (Martins, 2010). Therefore, scientific knowledge is impossible without a sound knowledge of mathematics.

Mathematics is made up of many branches like probability, statistics, algebra, geometry, trigronometry, number numeration and so on (Onuorah, 2016). This study specifically covers algebra. Algebra is an aspect of mathematics which deals with using of alphabets to represent

numbers. Algebra, which is one of the basic principles of mathematical learning, still maintains its importance in mathematics programmes. It is critically important because it is often viewed as a gatekeeper to higher-level mathematics which make it a required course for virtually every post-secondary school program (Kurumeh, 2006). It simplifies the solution of problems and indicates what is valid and what is not for every set of mathematical objects and the operations defined for them (Okafor, 2015). For example, in secondary schools, algebra of real numbers studies the properties of real numbers under the operation of addition, multiplication (repeated addition) and powers (repeated multiplication). To generalize those properties, algebra uses letters to represent numbers so x, y, ƶ etc are symbols used instead of numbers.

In spite of the importance and usefulness of algebra in mathematics learning and uses, Adeleke (2007) observed that one particular aspect of mathematics which students' problems are dominant is algebra. In the same line, Martin (2010) observed that algebra is also one of the branches of mathematics that many secondary school students find difficult to understand. Perhaps this is so because historically, algebra has represented students' first sustained exposure to the abstraction and symbolism that mathematics is powerful. Earlier, Kurumeh (2006) reported that students achieved poorly in public examination especially in the aspect of algebra. In addition, the summary results of students at credit pass and above reported from Anambra State Ministry of Education (AMSMOE) Examination in mathematics in 2014 to 2018 were 48.93%, 47.84%, 47.35% and 48.47% respectively. The report also indicated that the most difficult aspect of mathematics experienced by students is algebra.

Okafor (2011) reported that poor academic achievement of students in algebra is as a result of poor and ineffective instructional skills and methodologies by mathematics teachers. Azuka (2009) earlier asserted that mathematics classes where algebra is taught in the state secondary schools are overcrowded, most times one may find a single teacher teachingin a class of about 100 students. There are other factors which also contribute to poor achievement in algebra such as students attitude towards mathematics in general, inadequate number or qualified teachers to handle the algebra concepts in mathematics particularly at the junior secondary school level, and incompetency among teachers in teaching algebra concepts very well (Antoine, 2013). The major factor is that of teachers not being able to teach algebra using new innovations and strategy to stimulate students' interest. The incompetency among teachers exposes the students to solve algebra problem anyhow and thus have a notion that it is very difficult to handle. The students thus mightdevelop a dislike for algebra.

Eraikhuemen (2003) noted that students dislike algebra because, they feel that the topics are difficult and could not be understood easily. Some teachers lack techniques and materials in teaching some topics to the extent that if they have a choice, they will not teach such topics, also the teachers believe that these topics are difficult and are not easy to tech. For these reasons many students in secondary schools experience difficulties in learning some aspects of mathematics in the curriculum (Okafor, 2011). Azuka (2009) opined that teachers also experience difficulties in achieving effective teaching in the school system. In the light of the above it becomes necessary to consider other alternative teaching strategies like graphical organizers and metacognitive-reading strategies.

Graphical organizer is a visual display that demonstrates relationships between facts, concepts or idea (Antoine, 2013). Sometimes it is referred to as knowledge maps, concepts maps, story maps, flow diagram, sequence chart, compare/contrast, venn diagram, cause and

NAU Journal of Technology & Vocational Education Vol.6 No.1, July 2021. All Rights Reserved.
Website http://www.nauhtved.com.ng

effect diagram, main idea and details chart. Graphic organizer can be used at any point in the course of learning for effective understanding of concepts (Eraikhuemen, 2003). However they can be presented prior to learning to enable students organize and interpret new incoming information. According to Onuorah (2016) graphical organizers are some of the most effective visual learning strategies for students and are applied across the curriculum to enhance learning and understanding of subject matter content and it facilitate students' learning by helping them identify areas of focus within a broad topic aspect of algebra. They also help the learner make connections and structure thinking; students often turn to graphical organizers for writing projects. Okafor (2015) noted that graphic organizers have the capabilities to enhancing learning because graphic organizes are visual-spatial displays used to organize knowledge and represent relationships among pieces of information. The effectiveness of graphic organizers in improving mathematics comprehension has therefore prompted its usage in teaching algebra and other concepts in mathematics (Eissa, 2012). The process for using graphic organizers in the classroom involves, students brain storm and write down what they currently know about a given subject. It also involves students'ability to write down what they would like to learn about the subject and students record what they have learned about the subject.

Metacognitive reading involves the use of several repeated reading of a given concept during lesson presentation to improve students' understanding of that concept. Teong (2003 reported that metacognitive reading is classified into the following clusters: planning, monitoring and evaluating reading activities (Onuorah, 2016). Planning reading activities are used in activating learner's background knowledge to get prepared for reading (Amesi, 2003). Reading activities such as title, picture, illustration, heading and subheading can help readers grab the over view, or the general information in the text. Its structure such as cause and effect, question and answer, compare and contrast sub-concepts in a topic. Azuka (2009) stated that metacognitive reading activities are employed when reading a concept, learners may think about how to apply what they have read to other situation. To solve mathematical problem, one needs to repeatedly read mathematics textbooks, instruction, formulae and steps involve in solving mathematics problems.

In review of empirical studies on graphic organizer Eissa (2012) find significant improvement in the achievement of students exposed to graphic organizer than their counterparts in the traditional teaching method. Githua and Nyabwa (2008) also find out there is improvement on the student learning achievement through the use of graphic organizer in mathematics. Teong (2003) find that there is significant improvement in the achievement of students exposed to metacognitive reading strategy than their counterparts in other group. This study hope to find out the effectiveness of graphical organizer and metacognitive reading strategy on students' achievement in Algebra.

Statement of the problem

Literature (Amesi, 2003; Eissa, 2012; Githua&Nyabwa, 2008, Okafor, 2015) have shown that one of the major problems facing the teaching and learning of mathematics (algebra inclusive) in junior secondary school is the teaching method adopted by mathematics teachers. This is evident in the poor performance of students in both internal and external algebra mathematics examinations. Results from Anambra State Ministry of Education (AMSMOE) examination division reveal that from 2104 to 2018, majority of the students performed poorly in mathematics and the report also indicated that the most difficult aspect of mathematics for students is algebra. The problem of the study is: 'What would be the effects of graphical

organizer and metacognitive reading strategy on academic achievement of JSS 2 students in algebra?'

Purpose of the study

The study determined the effect of graphical organizers and metacognitive reading strategy on achievement of JSS students in algebra in Onitsha Education Zone of Anambra State. Specially, it sought to determine the:

1. Differences between the prê-test and post-test mean achievement scores of students taught algebra with graphic organizer, metacognitive reading and traditional teaching method.

Research Questions

1. What are the differences in the pre-test and post-test mean achievement scores of students taught algebra with graphic organizer, meta-cognitive reading strategies and the traditional teaching method?

Hypothesis

1. There is no significant difference in the posttest achievement scores of students taught algebra with Graphic Organizer, Metacognitive reading Strategies and traditional teaching method

Method

The design for this study is quasi-experimental.This study adopted a quasi-experimental research design using 3x4 factorial types. According to Susan and Thomas (2012), a 3 x 4 factorial design is an experiment with two factors (independent variables), one factor (independent variable) with 3 levels, while the other factor (independent) with 4 levels. The main advantage of this design is that it allows researchers to look for and control for the influence of most extraneous variables.Figure 2 presents the research design.

E_1 O_1 X_1 O_2 O_3

------- ---------- ----------

E_2 O_1 x_2 O_2 O_3

---------- -------- ----------

C O_1 -x O_2 O_3

Figure 2: Design of the Study

Where E_1 and E_2 represent the experimental groups 1 and 2, while C represent the control group. O_1 represents the test administered on the subject before treatment andO_2 administered after treatment. X_1 and X_2 the treatment groups 1 and 2.O_3 represents retention test or delayed posttest.-x means no treatment (Tg with TTM), ----- represent nonrandomized group.

The population for this study counts of all junior secondary year two (JSS2) students in all the 16 public secondary schools in Onitsha Education Zone of Anambra State. The population is 14433 JSS2 students. This population comprises 8571females and 5862 males.

The sample for the study comprised three intact classes of 50 JSS2 students each making it 150 students. The sample was obtained through multistage sampling procedure. Three co-educational secondary schools were purposively drawn from 16 secondary schools in Onitsha education zone based on accessibility to the researchers. Using sample random sampling

NAU Journal of Technology & Vocational Education Vol.6 No.1, July 2021. All Rights Reserved.
Website http://www.nauhtved.com.ng

technique (balloting with replacement), three schools were selected. With picking of folded paper, two schools were assigned to experimental group and the other school assigned to control group.

The instrument for data collection was Mathematics Achievement Test (MAT) developed by the researchers. The MAT consists of 50 items.The MAT was subjected to content validation with table of specification. The content validation was done by submitting the instrument together with the purpose of the study, scope, research questions and hypotheses to three experts. One in Measurement and Evaluation of Educational Foundation Department, one in Science Education Department of NnamdiAzikiwe University and a Mathematics Teacher.Trial testing of the MAT was done by administering the instrument to 20 JSS2 students from co-educational secondary school in Onitsha South Local Government Area of Anambra State. (School not in Onitsha Education zone). The data were used to estimate the reliability of the instrument using Kuder Richardson formula 20 (KR-20); of internal consistency of 0.87, hence the instrument was considered reliable for the study (Nworgu, 2015).The MAT were given to the students by their regular class teacher before the commencement of the lesson and after the lesson, the MAT are collected back from the students by their class teacher and the scores were used for data analysis.

Control of Extraneous Variables

The following procedures were adopted to control potential extraneous variables:

Experimenter Bias:-One of the major sources of effect on the study is the experimenter bias which is introduced when the experimenter becomes the investigation. To control this, the researcher would make use of researcher assistants for the study. Also to reduce the effect the same units of instruction will used for the two groups would be the inclusion of the various strategies involved in the implementation of the metacognitive instrumental strategies for the experimental group as an experimental variable.

Initial Group Differences:- In the selection of the subject for this study, intact classes would be used because of administrative inconveniences of disrupting normal class setting as practiced in the schools. This therefore would create a non-randomization effect. To control this initial group differences the subject in the group, an analysis of covariance (ANCOVA) will be applied in analysing the data from the study using the pre-test scores as covariates to the post-test scores.

Teacher Variable: To control the teacher variable for this study, the researcher will organize training for the three research assistants so that differences in the effectiveness of individual teachers would be made to follow the lesson plans strictly.

Hawthorne Effect; Hawthorne effect is said to occur where the subject become aware that they are being observed or used in a study and could result in gaps or difference in normal study. Hawthorne effect was controlled in this study by using the regular teachers known to the student.

Class interaction: The schools for the study have considerable distance from each other since the researcher is aware of possible interaction between the students in the experimental groups and control group.

Novelty Effect:-Novelty effect is created when a new teaching or instructional material is introduced in the teaching-learning endeavour. This effect may be positive or negative in nature. The presence of an experimenter for instance, would create this novelty effect on the students, in order to minimize that, the mathematics teachers of the students would be used for the study.

The data collected were analysis using statistical package for social science (SPSS) version 21, mean and standard derivation were used to analyzed the research questions. The null hypotheses for the study were tested using Analysis of covariance (ANCOVA) at 0.05 level of significance.

Results

Research Question 1: What are the differences in the mean pretest and post test scores of the students taught algebra with graphical organizer, metacognitive reading strategy and traditional lecture method.

Table 1: Difference in the mean pretest and posttest achievement scores of students taught algebra using graphic organizer, metacognitive reading strategies and traditional teaching method

Method	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
GO	50	24.04	6.27	63.62	9.27	39.58
MRS	50	23.64	7.43	55.98	8.49	32.34
TTM	50	22.36	6.26	49.48	5.93	27.17

Table 1 shows various means on achievement pretest and post test scores of the students taught algebra with graphical organizer, metacognitive reading strategy and traditional teaching method. From the table, the gain in mean of the achievement showed that Graphic organizer has 39.58, the gain in mean of the achievement showed that Metacognitive reading strategies has 32.34 while traditional method group gained 27.17. The mean difference between the Graphic organizer, Metacognitive reading strategies and traditional method groups revealed that Graphic organizer was effective in improving the achievement of students exposed to it more than other methods.

Hypotheses 1: There is no significant difference in the posttest achievement scores of students taught algebra with Graphic Organizer, Metacognitive reading Strategies and traditional teaching method

Table 2: Analysis of Covariance (ANCOVA) test of significant difference in the post-test achievement scores of students taught algebra with graphic organizer, metacognitive reading strategy and traditional teaching method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Squared	Rmk
Corrected Model	5015.599[a]	3	1671.866	25.805	.000	.347	
Intercept	34424.095	1	34424.095	531.339	.000	.784	
Pretest	6.279	1	6.279	.097	.756	.001	
Method	4921.791	2	2460.895	37.984	.000	.002	S
Error	9458.961	146	64.787				
Total	490942.000	150					
Corrected Total	14474.560	149					

NAU Journal of Technology & Vocational Education Vol.6 No.1, July 2021. All Rights Reserved.
Website http://www.nauhtved.com.ng

Table 2 shows that there is a significant difference between the mean achievement scores of students taught mathematics using graphic organizers, metacognitive reading strategies and those taught using traditional method with F(2,146) = 37.984, P = 0.000 <α = 0.05). The null hypothesis which states that there is no significant difference in the post-test achievement scores of students taught algebra with graphic organizer, metacognitive reading strategies and traditional teaching method was rejected. The post hoc pairwise comparisons is presented in table 3to obtain the directions of the differences.

Table 3.Pairwise comparison of the significant difference in the mean achievement scores of students taught with graphic organizers, metacognitive reading strategy and traditional teaching method

					95% Confidence Interval for Difference	
(I) method	(J) method	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
GO	MRS	8.027*	1.652	.000	4.762	11.293
	TTM	14.555*	1.678	.000	11.239	17.871
MRS	GO	-8.027*	1.652	.000	-11.293	-4.762
	TTM	6.528*	1.660	.000	3.246	9.809
TTM	GO	-14.555*	1.678	.000	-17.871	-11.239
	MRS	-6.528*	1.660	.000	-9.809	-3.246

Table 3 shows that there is a statistically significant difference between the group that took the graphic Organizer teaching approach and the metacognitive reading strategies (p = 0.000), as well as between the graphic Organizer teaching approach and traditional teaching method (p = 0.000). Furthermore, there is a statistically significant differences between the group that took the metacognitive reading strategies teaching approach and traditional teaching method (p = 0.00). The two experimental groups are significantly different from the control. Further, there is also a significant difference between the two experimental groups.

Discussion

The findings from research question 1 revealed that students taught algebra with graphic organizer and metacognitive reading strategies achieved higher than those taught with traditional teaching method. This corroborated with the findings of Eissa (2012) that, there is significant improvement in the achievement of students exposed to graphic organizer than their counterparts in the traditional teaching method.The finding from also showed that the mean achievement scores of students taught algebra with graphic organizer achieved higher than those taught with metacognitive reading strategies. This is in line with Githua and Nyabwa (2008) finding that there is improvement on the student learning achievement through the use of graphic organizer in mathematics.

Table 2, formulated based on hypotheses I revealed that there in significant difference between three groups (graphic organizer, metacognitive reading strategies and traditional teaching method. The findings agrees with the earlier findings of Teong (2003) who reported that there is significant improvement in the achievement of students exposed to graphic organizer and metacognitive reading strategies than their counterparts.Finally, the findings from table 3, therevealed that there is a statistically significant difference between the group that took

the graphic organizer teaching approach and the metacognitive reading strategies. The collaborate with the findings of Eissa (2012) that there is significant improvement of student exposed to graphic organizer than their counterparts.

Conclusion

The study found that students taught algebra with graphic organizer and metacognitive reading strategies achieved higher than those taught with traditional teaching method.

Recommendations

Based on the findings, the following recommendations were made.

1. Mathematics teachers should use graphic organizer and metacognitive reading strategies to facilitate their students' understanding and achievement in algebra branch of mathematics.
2. Authors of mathematics textbooks should integrate appropriate graphic organizers and metacognitive reading strategies in their textbooks which could be used for teaching and learning of algebra in junior secondary school.
3. School management board and administrators should provide teachers with resources that will enable them to achieve their stated goals in teaching and learning algebra.

References

Adeleke, J.O. (2007). Influence of sex difference of students on their achievement in secondary school mathematics. *Journal of the Mathematics Association of Nigeria*. 25(1), 109 – 113.

Amesi, J. (2003). *Aalgebra mathematics concepts*. London: Lexington Books.

Antoine, R.A. (2013). *The effect of graphic organizer on science education.Human body system.* (Unpublished master's Thesis). Louisiana State University. Retrieved from etd. Isu.edu/dvls/…/Antoine thesis. Pdf.

Azuka, B.F. (2009).*Active learning in mathematics classroom. Training named for capacity building workshop for secondary and primary schools building mathematical science teachers.* Abuja: National Mathematical Centre.

Eissa, M. A (2012).The effects of graphic organizer strategies intervention on academic achievement, self-efficacy and motivation to learn social studies.*Journal of Psycho-educational Science*, 1(1), 13 – 21.

Erakhuemen, S. (2003).*Social science information.Ethno science Today*. 30(4): 595-662.

Federal Republic of Nigeria (2013).*National Policy on Edition* NERDC, Press, Yaba. Lagos: RDC Press.

Githua, B. N &Nyabua, R. N. (2008).Effect of advance organizer strategy during instruction on secondary school mathematics in Kenya, Nakuru district. *International Journal of Science and Mathematics*, 6, 437 – 457.

Kurumeh, C.O. (2006). *Attitude of secondary school teachers towards theassessment of student's affective behaviour* (Unpublished M.Edproject).Department of Science Education University of Nigeria Nsukka.

Martin, R. (2010). Nigeria societal belief and language effect on the teachingand learning process in science. 32nd Annual Conference Proceeding of STAN 33-36.

Nworgu, B. G. (2015). Educational Research Methodology. Nsukka. Hallman

Okafor, A. (2011). *Conducting research in education and social science.*Enugu: Tashiuk Netuiniks Ltd.

Okafor, E.E. (2015). Domesticating Science, Technology and mathematics Education in Nigeria.(An Unpublished M. Ed Thesis), Kogi State College of Education Ankpa.

Onuorah, J.C. (2016). Gender differences in chemical problems solving among Nigerian students.*Research in Science and Technology Education.* 10(12) 189-201.

Susan, M &Thomas, R. C. (2012).C*onducting educational design research*. London: Routledge.

Teong, S. K. (2003). The effect of meta-cognitive training on mathematical and problem solving.*Journal of Computer Assisted Learning.* 19(1), 46 – 55. doi.10.1046/j.0266 – 4909. 2003.00005. x.

NAU Journal of Technology & Vocational Education Vol.6 No.1, July 2021. All Rights Reserved.
Website http://www.nauhtved.com.ng