

Research Article

Improving Primary School Pupils' Academic Achievement and Retention in Mathematics Using Jigsaw Teaching Method

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Abstract

This study focused on improving primary school pupils' academic achievement and retention in mathematics using jigsaw teaching method. It was guided by two research questions and two hypotheses. The pretest, posttest quasi experimental research design involving two groups was used for the study. The population of the study comprised of all the primary five (5) pupils of 2022/2023 academic session in Umuhia Education Zone of Abia state. The education zone has 201 primary schools with 4,447 primary five (5) pupils. The Two (2) primary schools with class teachers in primary five (5) that have mathematics background at NCE and Degree levels from Umuhia Educational Zone of Abia State were purposively sampled for the research. Simple random sampling technique was used in determining which school becomes the experimental and control group, 44 pupils participated as a sample for the study (19 males and 25 females). A Mathematics Achievement Test (MAT) and Mathematics Retention Test (MRT) were used for data collection. Research questions were answered using mean and standard deviation while the hypotheses were tested using Analysis of covariance at 0.05 alpha level, with the aid of SPSS version 21. The results showed a significant difference between the academic achievement and retention of the experimental group and control group in favour of the experimental group. It also revealed that there was no significant difference in the academic achievement and retention of male and female pupils taught geometry in the experimental group which implies that the use of the jigsaw teaching method is independent of gender. Based on the findings recommendations were made such as teachers should employ the use of cooperative method of teaching such as jigsaw teaching method in the teaching of geometrical concepts at the primary level of education to enhance pupils' academic achievement and retention. Finally, workshops and seminars on the use of cooperative method of teaching such as jigsaw Teaching Method should be organized by Ministry of Education for in-service primary school mathematics teachers.

Keywords

Mathematics, JIGSAW, Achievement, Retention, Primary School

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1. Introduction

The pertinent virtue of mathematics as well as its contributions to mankind development has earned the subject the prominence it enjoys among other school subjects [14]. The importance accorded to it in the school curriculum from primary to secondary levels reflects accurately the vital role played by the subject in contemporary society. As a subject, mathematics affects all aspects of human life in different levels. Generally the study of mathematics is considered as basis for the preparation of every informed citizen of any nation and serves as determinant in numerous career choices in life [8]. Mathematics is an indispensable tool in creating new knowledge. Today more than ever before, all fields of knowledge are depending on mathematics for solving problems, stating theories and predicting outcomes. It plays a role in everyday human activities and is also important in studying and understanding science and technology. It is in realization of its importance that many countries resort to making comprehensive and well-planned efforts towards the effective-teaching and learning of mathematics at all levels of their educational system through the development and implementation of innovative learning approaches of which Nigeria is not left behind [9].

In Nigeria today, pronounced achievement in technological development will be hampered if the potential scientists, engineers and technologists are not fully equipped with sound knowledge of mathematics at foundational level (primary level of education). Mathematics being the basic foundation for economic and technological development requires solid foundation at primary stage of education [10]. It is a well known fact that sound educational foundation is the base for effective economic and technological takeoff of any nation. Primary education is given in schools for children 6-12 years and above. Since the rest of education system is built upon it, primary level of education is the key to success or failure of the other levels of education. Primary education creates opportunity for each child to acquire a basic education which will enable him/her function efficiently and creatively in his environment [12]. Teaching at this level of education requires the engagement of well trained teachers who will develop pupils with the required knowledge to attain national educational objectives, especially in the area of economic and scientific development in Nigeria. According to Alio, B.C. and Okafor, P.C., Nigerian National Policy on Education emphasized that primary education should lay a sound basis for economic, scientific and reflective thinking as well as provide the child with basic tools for further educational advancement including preparation for trades and crafts of the locality [4]. Hence for any nation to achieve meaningful technological development there must be effective teaching and learning of Mathematics to its citizens especially at primary school level of education which is the foundational level of educational system.

Obilor, W. E. et al. noted that there is general fear and hatred for mathematics as a subject. [15] A situation which resulted in declined interest and achievement in the subject (mathematics). Many students have the obnoxious notion that mathematics learning is an unattainable task. Not many school children have interest in the subject even from the introduction of mathematics [8]. A great majority of students believed that mathematics competence is reserved for a selected few. Unfortunately, many adults also share this same feeling. The adult members of our society comprising the parents, siblings and teachers are the most needed advisers to students and should not share the same feeling as some students believed that mathematics competence is reserved for a selected few. Adedayo W. K. Observed that the problem of failure in mathematics at primary and secondary school levels has always been attributed to teacher's failure to use appropriate method of teaching thereby resulting them to adopt traditional method of teaching, where they do the talking while the learners listen [1].

In enumerating ways of promoting effective methods of teaching Mathematics, Mohanty, S. B. identified among other factors, that teaching of Mathematics should adopt the guided discovery method of teaching that encourages cooperative learning, where a learner should be guided to work as an individual or as a group in order to find out information and understand concepts through appropriate activities and questioning techniques [11]. The author emphasized that, students should be encouraged to discover patterns in Mathematics leading to finding rules and formulae, since just giving out the rule or formulae leads to rote learning without proper understanding. In other words, teachers of Mathematics should develop teaching methods that will ensure that learners understand mathematical concepts being taught and not just memorizing for the sake of passing examinations. This has called for the need for mathematics teachers and stakeholders in education sector to develop a lot of initiatives and innovative ideas that should motivate and involve the learners in the study of mathematics through the use of cooperative teaching approaches such as jigsaw teaching method.

Jigsaw is cooperative teaching method that allows for independent thinking and collaborative learning. Jigsaw involves learners completing their own research, and teaching it to the class. Jigsaw Learning Strategy is one of the cooperative learning models that reduces conflict among learners, promotes better learning, improves learner motivation, and increases enjoyment of the learning experience [19]. This approach has been claimed to minimize the competitiveness in the learning environment by encouraging learners to work together [6]. The Jigsaw Strategy is an efficient way to learn a course material in a cooperative learning style. The jigsaw process encourages listening, engagement, and empathy by giving each member

of the group an essential part to play in the academic activity.

In jigsaw approach, Group members must work together as a team to accomplish a common goal; each person depends on all the others. This "cooperation by design" facilitates interaction among all learners in the class, leading them to value each other as contributors to their common task [17]. The Jigsaw strategy places great emphasis on cooperation and shared responsibility within groups. The success of each group depends on the participation of each individual in completing their task. This means that Jigsaw strategy effectively increases the involvement of each learner in the learning activity. Sabbah, S. S. observed that the jigsaw strategy guides learners to take charge of their learning, peer tutoring, communication skills and as well improve their retention ability in what is being learnt [18]. At primary level of education, the use of cooperative instructional strategies such as jigsaw among others are designed to arouse the interest of pupils and as well improve their participation towards the learning of science related subjects including mathematics which may play important role in improving their academic achievement.

Achievement means to reach a required standard of performance, or to carry out a task successfully [2]. In this study, achievement refers to reasoning progress of students in terms of passes gotten from teacher-made test/standardized test in mathematics. Hence, the researcher upholds the view that, students' academic achievement entails successful academic progress attained through effort and skill [2]. It involves the determination of the degree of performance and attainment of individuals in tasks, courses or programmes to which the individuals were sufficiently exposed. The academic achievements of primary and secondary school pupils/students in mathematics have not been encouraging and have been persistently poor year after year [3]. Teaching mathematics with cooperative strategies and approaches that are designed to meet learning needs of learners may ensure that all learners have equal opportunities to learn irrespective of their learning abilities and as well may improve their retention ability.

Edoho, E. A et al viewed retention as the ability to remember and recall things during and after educational activities [7] while Bichi, S. S. viewed retention as the ability to store and consequently reproduce things experienced or learned by an individual at a later time especially after graduation from any educational level [5]. Obi, C. N. et al defined retention as the ability to remember things [13]. In their work on checkmating gender differentials in pupils' achievement and retention in mathematics using origami teaching aid, it was stressed that retention is the ability to retain what has been learnt. This implies that before retention comes into play, learning must have taken place. According to Ogbonna in Obi C. N. et al when a person engages in practice of training activities and when observation of his performance shows that there is a change in performance; learning is usually assumed to have occurred [13]. Therefore,

one can simply put, learning is an observable change in behaviour and when one is able to recall what has been learnt as the need arises, it can be said that retention has taken place. This implies that, performance of a learner is proportional to the amount of information retained and therefore the extent of achievement has to do with the degree of retention of what a learner has been taught especially at primary level of education, where educational foundations are laid [13].

In as much as all science and technology based courses and programmes are highly dependent on mathematics, efforts should be made towards the development of learning activities that will engage learners during teaching and learning of mathematical concept at all levels of education, in order to improve academic achievement and retention among learners in the subject irrespective of their gender among other factors. Hence, the need to carry out a study on improving primary school pupils' academic achievement and retention in mathematics using jigsaw teaching method.

Specifically, the study:

1. determined the effect of using jigsaw teaching method on academic achievement of pupils in mathematics;
2. determined the differential effect of using jigsaw teaching method on retention of pupils in mathematics;

2. Hypotheses

The following null hypotheses (H_0) were tested at 0.05 level of significant in the study:

H_{01} : There is no significant difference between the mean achievement scores of pupils taught mathematics using jigsaw teaching method and those taught without using jigsaw Teaching Method.

H_{02} : There is no significant difference between the mean retention scores of pupils taught mathematics using jigsaw teaching method and those taught without using jigsaw Teaching Method.

2.1. Methodology

This study adopted quasi-experimental research design because it is not possible or practical to control all the key factors in the study, so it becomes necessary to implement a quasi-experimental research design for this study. Specifically, the design was pretest-posttest non-equivalent control group design. Intact classes were used instead of randomly composed samples. The use of intact classes was to ensure no alteration of regular class period since primary school authorities in Abia State do not allow their lesson periods to be altered.

The population of the study comprised of all the primary five (5) pupils of 2022/2023 academic session in Umuahia Education Zone. The education zone has 201 primary schools with 4,447 primary five (5) pupils (Abia State Universal Basic Education Board, 2022/2023 academic

record). The sample size for this study consisted of 47 pupils. This comprised 21 male and 26 female primary five (5) pupils selected from two schools that were selected through purposive sampling technique in Umuahia Education Zone. The schools were randomly assigned into experimental and control groups. The researchers developed two instruments called Mathematics Achievement Test (MAT) and Mathematics Retention Test (MRT) which consisted of 40 items adopted from past question papers in National Common Entrance Examination (NCEE) and First School Living Certificate (FSLC) examinations in area of plane shape geometry covered during the study. The items of the Mathematics Achievement Test (MAT) were put together with a Table of Specifications to ensure they were content valid. The Kuder-Richardson (KR- 20) formula was used to ascertain the reliability of the MAT. The value of ‘r’ was found to be 0.83.

2.2. Experimental Procedure

The researchers within the first week obtained permission from the sampled schools. They briefed the research assistants (who were the regular mathematics teachers in the schools) on the activities to be carried during the research. They administered the research instrument to both experimental and control groups as pre-test in their respective schools. The pre-tests were scored and kept under the custody of the researchers. In the subsequent four weeks, pupils in jigsaw experimental group received instruction on plane shape geometry according to activities in lesson plan

designed for their group, while students in control group received instruction on plane shape geometry using conventional method of teaching lesson plan. The treatment experimental and control groups received strictly followed the steps in the lesson plan made available to the research assistants by the researchers for each of the groups. On the sixth week, the instrument (MAT) was re-administered to both experimental and control groups as post-test. The post-test of the groups were scored by the researchers. The score from pre-test and post-test were used in determining the academic achievement of students in Mathematics. A gap of two (2) weeks was given before the re-administration of MRT to learners to determine their retention ability.

Data collected from the pretest/posttest using MAT and the one collected using MRT were recorded for the two groups. Data collected were analyzed with respect to the research hypotheses formulated for the study. Descriptive statistics of mean, standard deviation and Inferential statistics of Analysis of Covariance (ANCOVA) were used to test all the hypotheses at significant level of 0.05.

3. Results

3.1. Hypothesis One

There is no significant difference between the mean achievement scores of pupils taught mathematics using jigsaw teaching method and those taught without using jigsaw Teaching Method.

Table 1. The mean achievement scores of pupils taught mathematics using jigsaw method and those taught using lecture methods.

Variables	N	Pre-Test Mean	SD ofPre-Test	Post-Test Mean	SD ofPost-Test
JIGSAW	21	33.68	14.37	71.58	14.43
lecture method	23	37.91	14.52	52.78	14.92

Table 1 above shows the mean achievement scores of pupils who were taught mathematics using jigsaw method and those taught using lecture methods with their corresponding standard deviations. From table 1, it could be seen that the pupils in jigsaw method had a pre-test mean achievement score of 33.68 with a standard deviation of

14.37, while in post-test mean achievement score, the pupils scored 71.58 with a standard deviation of 14.43. For the pupils in lecture method, it was observed that they had a pre-test mean achievement score of 37.91 with a standard deviation of 14.52, while in their post-test mean achievement score they scored 52.78 with a standard deviation of 14.92.

Table 2. Analysis of covariance on the mean achievement scores of pupils taught mathematics using jigsaw method and those taught using lecture methods.

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	DecisionRule
Corrected Model	1287.165 ^a	2	321.791	59.132	.000	.731	

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	DecisionRule
Intercept	2755.635	1	2755.635	506.376	.000	.853	
PRETEST	259.885	1	259.885	1.70956	.195	.354	
Groups	19.302	1	19.302	47.7	.000	.019	S
Error	473.443	41	5.442				
Total	33470.000	44					
Corrected Total	1760.609	43					

a. R Squared =.950 (Adjusted R Squared =.949)

Table 2 shows that the F-ratio is 47.7 with 1 degree of freedom. However, since the associated alpha level of .000 is less than the p-value of 0.05 ($p > 0.05$), the null hypothesis which states that there is no significant difference between the mean achievement scores of pupils taught Mathematics using jigsaw method and those taught using lecture method is not accepted. This implies that there is significant difference between the mean achievement scores of pupils taught Mathematics using jigsaw method and those taught

using lecture method.

3.2. Hypothesis Two

There is no significant difference between the mean retention scores of pupils taught mathematics using jigsaw teaching method and those taught without using jigsaw Teaching Method.

Table 3. The mean retention scores of pupils taught mathematics using jigsaw method and those taught using lecture methods.

Variables	N	Pre-Test Mean	SD ofPre-Test	Post-Test Mean	SD ofPost-Test
JIGSAW	21	33.68	14.37	76.58	14.76
lecture method	23	37.91	14.52	51.62	13.34

Table 3 above shows the mean retention scores of pupils who were taught mathematics using jigsaw method and those taught using lecture methods with their corresponding standard deviations. From Table 3, it could be seen that the pupils in jigsaw method had a pre-test mean retention score of 33.68 with a standard deviation of 14.37, while in post-

test mean retention score, the pupils scored 76.58 with a standard deviation of 14.76. For the pupils in lecture method, it was observed that they had a pre-test mean retention score of 37.91 with a standard deviation of 14.52, while in their post-test mean retention score they scored 51.62 with a standard deviation of 13.34.

Table 4. Analysis of covariance on the mean retention scores of pupils taught mathematics using jigsaw method and those taught using the conventional teaching methods.

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	DecisionRule
Corrected Model	1368.165 ^a	2	684.083	60.202	.000	.731	
Intercept	2977.358	1	2977.358	524.752	.000	.925	
PRETEST	286.688	1	286.688	1.9021	.122	.398	
Groups	21.254	1	21.254	1.657	.000	.032	S
Error	497.568	41	12.136				
Total	35241.000	44					

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	DecisionRule
Corrected Total	1855.609	43					

a. R Squared = .950 (Adjusted R Squared = .949)

Table 4 shows that the F-ratio is 1.657 with 1 degree of freedom. However, since the associated alpha level of .000 is less than the p-value of 0.05 ($p > 0.05$), the null hypothesis which states that there is no significant difference between the mean retention scores of pupils taught mathematics using jigsaw method and those taught using lecture method is not accepted. This implies that there is significant difference between the mean retention scores of pupils taught mathematics using jigsaw method and those taught using lecture method.

4. Discussion of the Findings

The results in the test of hypotheses have shown that pupils who were taught mathematics using jigsaw teaching method performed significantly better than those taught using lecture method. This study is in tandem with Obilor W. E. et al and Okeke A. M., who discovered that academic achievement and retention were significantly improved when learner were exposed to jigsaw strategy in mathematic than when exposed to lecture method [15, 16] This implies that guiding learners and getting them involved through the use of jigsaw teaching approach during learning of mathematical concepts such as plane shapes geometry, encourages learners to engage in cognitively planned learning activities, organize shared thoughts, reinforcement and evaluation of what they are assigned to accomplish through team work activities in jigsaw approach.

This study is in support of Uche S. A. et al, and Okowonjo. I. J. et.al who in their works stated that using jigsaw approach in teaching involves a learning situation where students are deeply and actively involved in the learning task, selecting instructional materials, setting goals as well as determining the pace and rate of progress in learning [20, 3]. The outcome of the finding is very instructive to both teachers and administrators. It then implies that the use of jigsaw teaching method should be further explored and harnessed for effective teaching and learning of mathematical concepts. In this regard, teachers need to prepare in both technical knowhow and methodology that should facilitate the use of jigsaw approach in teaching mathematical concepts especially in plane shape geometry if the poor achievement and retention of learners recorded in recent times are to be improved.

The outcome of the findings is instructive to teachers, administrators and government. It implies that teaching methods like jigsaw teaching method among others should be employed by teachers, government, and school administrators during teaching of mathematical concepts to improve level of

understanding mathematical concepts by pupils especially in area of geometry. This will in turn reduce poor achievement in mathematics especially at primary school level of education.

5. Conclusion

Having seen the effects of using jigsaw teaching method (especially at primary school level of education) in improving pupils' academic achievement and retention, which is also an indicator of improvement in knowledge in mathematics especially in the area of geometry, researchers and mathematics teachers will be motivated to try out such teaching methods/other learner centred methods that will actively engage pupils and student during learning of mathematical concepts to find out their effectiveness in teaching and learning of other mathematical concepts at secondary and tertiary levels.

6. Recommendation

Based on the result of the findings of this study, the following recommendations were made:

1. Mathematics teachers should intensively employ the use of jigsaw teaching method that will actively involve pupils and students during teaching learning process which will provide opportunity for them to interact with one another to enhance their retention and achievement in mathematics.
2. Federal/State Government and school proprietors should ensure that mathematics teachers use instructional approaches such as jigsaw teaching method that will actively involve learners and give them participatory opportunity through the use of task that will engage them during teaching and learning of mathematical concepts.
3. Workshops/Seminars should be organized by Government at state and federal levels and by other relevant professional agencies (MAN, STAN etc) for Mathematics educators, in-service mathematics teachers, and students/pupils to enable them learn how to use jigsaw teaching method aided approach to enhance the teaching and learning of Mathematics in schools at all levels.

Abbreviations

MAT	Mathematics Achievement Test
MRT	Mathematics Retention Test

NCEE National Common Entrance Examination
 FSLC First School Living Certificate
 ANCOVA Analysis of Covariance

Author Contributions

Obilor Wisdom Enyinnaya: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Writing – original draft

InekweIsrael Onwuegbu: Supervision, Validation, Visualization, Writing – review & editing

Ogbonna Cecilia Chinyere: Supervision, Validation, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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