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EFFECT OF INTERACTIVE JIG-SAW TEACHING METHOD ON SENIOR SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN QUADRATIC EQUATION

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ABSTRACT

This study examined effect of interactive jig-saw teaching method on senior secondary school students' academic achievement in quadratic equation. The study adopted the quasi-experimental pre-test, post-test control group design. Two research questions and two research hypotheses guided the study. The population for the study were all the 11,320 senior secondary school class one (SS 1) students in all the 204 co-education secondary schools in Anambra state. The sample consisted of 422 SS1 students (186 males & 236 females), in getting the sampled students, purposive sampling technique was used to spread the selection across the six education zones in Anambra State. Two Education zones (Awka & Otuocha) were used for the study because Awka education zone is considered as an education advanced zone while Otuocha education zone is considered a backward education zone by the researchers. The instrument for data collection was named Mathematics Achievement Rest (MAT) adapted from objective questions from WAEC past question papers. MAT comprised of 50 item questions. The reliability of MAT was tested using Kuder Richerson 20 and the value obtained was .75 indicating that the instrument was reliable. Data obtained were analysed using mean, standard deviation for the research questions and Analysis of Covariance (ANCOVA) for hypotheses. The result showed that thought both interactive jig-saw method of teaching which was used in treatment group and traditional teaching method which was used in control group improved secondary school students' academic achievement in quadratic equation, but students taught Mathematical concept of quadratic equation using interactive jig-saw teaching method achieved better than those taught the same concept using traditional teaching method. The study also proved a significant difference in achievement between students taught quadratic equation using interactive jig-saw and those taught the same concept using traditional teaching method in favour of those taught with interactive jig-saw method. Finally, the study revealed no significant difference in achievement between male and female secondary school students taught quadratic equation using interactive jig-saw in experimental group and traditional teaching method in control group. Based on the findings recommendations and conclusions were made.

Keywords: Mathematics, Interactive jig-saw and Quadratic equation

Introduction

Mathematics is defined as an organized body of knowledge where ideas, principles and concepts involving numbers are logically built. Having originated from the Greek word "mathematica" which was generally known in early writing to indicate any subject of instruction or study dealing with the practical problems of counting and recording of numbers with the possible exception of astronomy, Mathematics occupies a central position in school

curriculum as it popularly called Mathematics education (Okigbo & Mbakwe 2016).

Mathematics education is the practice of teaching and learning Mathematics as well as the scholarly research in the practice. Okeke et. al. (2017) stated that emphasis on the need for education in every nation is incomplete if mathematics education is not considered because it is the basis of all knowledge whether art, science and technology as well as commerce and its everyday applications. This is the reasons objectives of Mathematics education at secondary school level as stated in the National Policy on Education (FGN, 2016) are as thus; to develop a positive attitude towards learning Mathematics, to communicate mathematical ideas, to perform mathematical operations and manipulations with confidence, speed and accuracy, to acquire knowledge and skills for further education and training and to think and reason precisely, logically and critically in any given situation. Based on the following objectives, the Federal Government of Nigeria in the National Policy on Education (FGN, 2016) made mathematics one of the compulsory subjects in secondary schools. In line with the (FGN) Chukwurah and Ifeanyi-Obiorah (2017) asserted that Mathematics education is the basis of learning vocational–technical education.

Going by the above definitions, one will see that the importance of Mathematics and Mathematics education cannot be over emphasized because it is used to explain the complexities of modern spirit in the business, economic, academic, engineering and medical setting. Thus the knowledge and use of Mathematics pervades all facets of life and plays a vital role in the development of a nation and her technology. The many uses and applications of Mathematics in the home, offices, business, industries, agriculture, decision making and even in governance is quite enormous, thus Okigbo and Mbakwe(2016) averred that the increasing importance and attention given to Mathematics stem (science technology engineering and mathematics) from the fact that it is regarded as the backbone of scientific development of a nation or a society. The line of demarcation between the developed and under-developed nation is based on their level of Mathematics attainment and ingenuity because without Mathematics there will be no modern technology and without modern technology there will be no modern society.

Despite the importance of Mathematics in development of a nation, Iketaku (2019) reported that the statistics from the West African Examination Council (WAEC) Chief Examiner's Reports from 2015 to 2021 show that for the past 7 years (2015-2021) the percentage of students that got credit and above passes in Mathematics is within the range of 5.30% to 53% with an average percentage credit and above pass of 34.37% during the period. Iketaku further noted that students' poor performance is more visible in algebra. Quadratic equation therefore which is a topic in algebra is the topic of concern in terms of teaching at the foundation class of the Senior Secondary School. This means that there is no doubt that mathematics achievement in senior secondary schools is very poor. Students do not achieve well or highly in senior school certificate examinations in either National Examination Council (NECO) or WAEC (Ogbozor2018; Adetola 2015). Ogbu (2015) attributed strongly that students' poor academic achievement in quadratic equation is as a result of phobia and non-usage of

innovative teaching method in teaching the topic.

Adetola (2015) opined that there are many kinds of innovative teaching method that have help in greater academic achievement in Mathematics concepts and. Examples of such are think- pair share instructional strategy, computer based assisted instructional strategy, and self-regulated learning strategy, instructional scaffolding and interactive jig-saw method (Chukwurah & Ifeany-Obiorah, 2017). All the above mentioned interactive methods of instruction are beneficial to teaching-learning process but the researchers have decided to investigate on the effect of interactive jig-saw method of instruction on secondary school students' academic achievement in quadratic equation base on WAEC chief examiners' report as mentioned earlier.

Interactive jig-saw technique of instruction is therefore a co-operative learning method that brings about both individual accountability and achievement of team goals. This process derives its name from the jig-saw puzzle as this process involves in putting the parts of the assignment together to form a whole picture of the assignment. The assignment is divided into parts and the class is also divided into the same number of groups as that of the assignments. It is a method of organizing classroom activity that makes students dependent on each other to succeed. It breaks classes into groups and breaks assignments into pieces that the group assembles to complete the jig-saw puzzle. Each of these groups is given a different topic to learn. These groups are shuffled to form new groups consisting of members from each group.

The interactive jigsaw method of teaching was developed by Elliot Aronson in 1971.In the pioneer experimentation of the jig-saw method, Elliot created a multiple of groups and then assigned students to the groups. Then, academic topic was divided into sections. Each member of the group is assigned a section of study on which he or she has to study to become an expert. The members of the expert groups work together to learn the material or solve the problem, then return to their jig-saw groups to share their learning (Amedu et. al. 2015). Chinna and Reddy (2017) opined that students interact with each other in the same group to acquire and practice the elements of subject matter in order to solve a problem as well as complete a task of achieving a goal. These abilities according to Johnson, Johnson and Holubecas cited in Chinna can be described as key elements of jig-saw strategies which should include positive interdependence, individual accountability and small- group skills and group processing.

Yemi et. al. (2018) observed that students taught Mathematics concepts of set theorem using interactive jig-saw method achieved better than those taught with traditional teaching method. Yemi et.al. further averred that there is a significant difference in achievement between students taught set theorem using interactive jig-saw method and traditional teaching method in favour of those taught with traditional teaching method. Similarly, Ndukwe and Timayi (2018) averred that interactive jig-saw increases students' academic achievement among federal collage of education students. Ndukwe and Timayi reported there is a significant difference in achievement between federal collage of education students taught computer using interactive jig-saw method and those taught with traditional teaching method in Bayelsa state Nigeria in favour of those taught with

interactive jig saw method not minding gender involvement.

Contrary, Olanrewaju (2018) observed that though there is a significant difference in achievement among secondary school students taught Mathematics concept of number and numeration in Gwagwalada area council of the federal capital territory Nigeria using interactive jig saw method and traditional teaching method in favour of those taught with interactive jig-saw, male students achieved better in both teaching methods than their female counterpart. Musa and Samuel (2019b) consented to the assertion when they observed that male secondary school students taught indices at Western Senatorial District of Nasarawa State, Nigeria using interactive jig saw method and traditional teaching method achieved better than their female counterpart though generally students taught using interactive jig-saw achieved more than those taught Mathematical concept of indices using traditional method.

In contrary manner, Samuel (2018a) observed that female secondary school students taught basic science in co-education schools in Benue north senatorial zone, Benue State, Nigeria using interactive jig-saw and traditional teaching method, achieved more than their male counterpart though students' taught basic science using interactive jig-saw generally achieved better than those taught basic science using traditional teaching method. The author further maintained there is a significant difference between male and female students taught basic science using interactive jig-saw method and between male and female taught basic science using traditional teaching method in favour of female students in both teaching methods. Meanwhile Areelu et. al. (2018) did not observed a mean and significant differences in achievement among secondary school students taught Mathematics concept of geometry in Lagos state using interactive jig-saw method and those taught with traditional teaching method. Furthermore, Areelu et. al did not observe a mean and statistical significant differences between male and female students taught Mathematics concept of geometry using interactive jig-saw method and those taught geometry using traditional teaching method in Lagos state.

From the foregoing, it appears the question of whether interactive jig-saw method enhances students' academic achievement or it does not enhance it in Mathematics and other subjects has not been concisely answered because empirical studies reviewed in this study have produced diverse and contradictory results. Similarly, the issue of gender difference on effect of interactive jig-saw method on secondary school academic achievement in Mathematical concept quadratic equation using traditional teaching method in control group especially in Anambra state has not has not been resolved and therefore subject to further investigation. Thus, this study focused on effect of interactive jig-saw teaching method on senior secondary school students' academic achievement in quadratic equation in Anambra state.

Research Questions

The following research questions guided the study:

1. What is the mean and standard deviation of achievement scores of the students taught quadratic equation using interactive jig-saw method and those taught using traditional teaching method?

2. What is the mean and standard deviation of achievement scores of male and female students taught quadratic equation with interactive jig-saw method and those taught using traditional teaching method?

Hypotheses

The following hypotheses tested at .05 level of significance guided the study.

1. There is no significant difference in the mean and standard deviation of achievement scores of the students taught quadratic equation using interactive jig-saw method and those taught using traditional teaching method.
2. There is no significant difference in the mean and standard deviation of achievement scores of male and female students taught quadratic equation using interactive jig-saw method and those taught using traditional teaching method.

Research Method

The design adopted for the study was quasi– experimental research design because intact classes were used to avoid disruption of normal class lessons. The area of study is Anambra state. The population for the study were all the 11,320 senior secondary school class one (SS 1) students in all the 204 co-education secondary schools in Anambra state (PPSSC, 2022). The sample consisted of 422 SS1 students (186 males & 236 females). In getting the sampled students, purposive sampling technique was used to spread the selection across the six education zones in Anambra State. Two Education zones (Awka & Otuocha) were used for the study because Awka education zone is considered as an education advanced zone while Otuocha education zone is considered a backward education zone by the researchers. Then by balloting, three schools were selected from each of the zones and intact classes were assigned to control and treatment groups. In Awka education zone, three intact classes of 140 students for the treatment group (60 males & 80 females) and three intact classes of 92 students for the control group (41 males &51 females) were used, while in otuocha zone, three intact classes of 110 students (50 males & 60 females) was used as the treatment group and three intact classes of 80 students (45 males &35 females) were used for the control group. The choice of co-education school was because gender is one of the variables under study. The study covered a period of five weeks. First week was for familiarizing visit and training of the Mathematics teachers in the selected schools who act as research assistants. First day of the second week was used to administer the pretest achievement test and pre interest inventory to the students involved in the study. Second day of the second week was used to teach quadratic equation to experimental groups using interactive jig-saw method (JS) and control group using traditional teaching method (TTM) for three weeks. Mathematics teachers were given detailed information and instructions concerning the study. The teachers in both groups used lesson plan prepared by the researchers for both the experimental (JS) and control groups (TTM). At the end of the fifth week, both experimental JS and control group TTM were post tested base on what they are taught and were also given interest inventory questions to answer. Marks were awarded to each question prepared for both experiment test group and control group achievement test which constituted fifty (50) questions. If

all the questions were answered correctly by the student, his/she is entitled to hundred (100) marks. Data collected from achievement test and interest inventory questions were used for analysis. The instrument for data collection was named Mathematics Achievement Rest (MAT) adapted from objective questions from WAEC past question papers. MAT contained 50 objective questions. To ensure the reliability of the instrument, the fifty (50) objective achievement questions were administered to a group of twenty students in Delta state which is outside the place of the study. The results were subjected to Kuder 20 Richardson. A mean coefficient of .75 was obtained indicating that the instrument was reliable. The date obtained from the pretest and post-test of MAT was analyzed using mean, standard deviation for research questions and Analysis of Covariance (ANCOVA) to test the hypotheses

Presentation of Results

The results of this study were presented in line with the research questions and the hypotheses as follows.

Research Question 1: What is the mean and standard deviation of achievement scores of the students taught quadratic equation using interactive jig-saw method and those taught using traditional teaching method?

Table 1: Mean and Standard Deviation Mathematics Achievement scores of Secondary School Students taught Quadratic Equation with Jig-saw Method and those taught with Traditional Teaching method

		Pretest		Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
JS	250	18.43	10.14	46.09	8.95	27.66
TTM	172	17.06	7.58	18.60	7.57	1.54

The results in Table 1 shows that the pre-test and posttest mean achievement scores of secondary students taught quadratic equation with interactive jig- saw method as measured by Mathematics achievement test were 18.43 and 46.09 respectively while the standard deviations were 10.14 and 8.95. On the other hand, pre-test and posttest mean achievement scores of secondary students taught quadratic equation with traditional teaching method as measured by Mathematics achievement test were 17.06 and 18.60 respectively while the standard deviation were 17.06 and 18.60.

The standard deviation scores for the pretest for both groups were higher than the standard deviations for the posttest. This suggests more variability in the pretest scores of the students than the post test scores. More of the scores near the mean in the pretest than in the post test. Since the pretest mean is smaller than the posttest means, in both groups, the treatment which is interactive jig-saw method improved the achievement of quadratic equation generally. Since posttest mean for experimental group is higher than the posttest means of the control, and since the post test of standard deviation for experimental group is smaller than the post

test of standard deviation for control group, the experimental group treatment is more effective than the control group.

The mean gain score for students taught quadratic equation with interactive jig-saw method is 27.66 while that of traditional teaching method is 1.52. This represents a mean difference of 26.14 in favour of students taught quadratic equation with interactive jig- saw which implies that students taught with interactive jig- saw achieved better in Mathematics concepts used than those taught using traditional method.

Research Question 2: What is the mean and standard deviation of achievement scores of male and female students taught quadratic equation with interactive jig-saw method and those taught using traditional teaching method?

Table 2: Mean and Standard Deviation Mathematics Achievement scores of Male and Female Secondary School Students taught Quadratic Equation with Interactive Jig-saw Method and those taught with Traditional Teaching method

			Pretest		Posttest		
Groups	Gender	N	Mean	SD	Mean	SD	Mean Gain
JS	Male	110	22.46	14.10	46.40	10.41	23.94
	Female	140	15.26	2.3	45.86	7.63	30.60
TTM	Male	86	19.17	9.92	20.20	9.92	1.03
	Female	86	14.97	2.8	16.71	3.11	1.74

Table 2 shows mean and standard deviation achievement scores of male and female students taught quadratic equation with interactive jig-saw method and traditional teaching method as measured by Mathematics achievement test.

From the result the pretest mean achievement score and standard deviation of male students taught quadratic equation with interactive jig-saw were 22.46 and 14.10 respectively. Their posttest means achievement score and standard deviation were 46.40 and 10.41 respectively. This gave a mean gain scores of 23.94. Also, the pretest mean achievement score and standard deviation of the female students taught quadratic equation with interactive jig-saw were 15.26 and 2.3. Their posttest means achievement score and standard deviation were 45.86 and 7.63 respectively. This gave a mean gain scores of 30.60. The standard deviation scores for the pretest for the male and female students were higher than the standard deviations for the post test. This suggests more variability in pretest scores of the students than the post test scores. More of the scores near the mean in the posttest than in the pretest. Since posttest mean score for male is higher than the posttest mean score of the female, the male students achieved higher than their female counterpart in use of interactive jig -saw. However, the mean gain difference between male and female students is 6.66 in favour of male students. This implies that in use of interactive jig-saw method, male students achieve higher in

quadratic equation Mathematic concept than their female counterpart.

More so, the result shown that the pretest mean achievement score and standard deviation of male students taught quadratic equation with traditional teaching method were 19.17 and 9.92 respectively. Their posttest means achievement score and standard deviation were 20.20 and 9.92 respectively. This gave a mean gain scores of 1.03. Also, the pretest mean achievement score and standard deviation of the female students taught quadratic equation with traditional teaching method were 14.97 and 2.8. Their posttest means achievement score and standard deviation were 16.71 and 3.11 respectively. This gave a mean gain scores of 1.74. The standard deviation scores for the pretest for the male and female students were lower than the standard deviations for the post test. This suggests less variability in pretest scores of the students than the post test scores. More of the scores near the mean in the pretest than in the posttest. Since posttest mean score for male is higher than the posttest mean score of the female, the male students achieved higher than their female counterpart in use of traditional teaching method. However, the mean gain difference between male and female students is 0.71 in favour of male students. This implies that in use of traditional teaching method, male students achieve higher in quadratic equation Mathematic concept than their female counterpart.

Hypotheses

Ho_1: There is no significant difference in the mean and standard deviation of achievement scores of the students taught quadratic equation using interactive jig-saw method and those taught using traditional teaching method.

Table 3: The ANCOVA Results of Achievement Scores of Students in the Experimental and Control Group as Measured by MAT.

Source of Variation	Mean Difference	Std. Error Difference	df	F	Sig
PRETEST	1.36223	.90986	420	4.373	.037
JS/TTM		.86323	417.139		
POSTTEST	27.49135	.83377	420	8.632	.003
JS/TTM		.80864	402.319		

The result in Table 1 shown that there is a significant difference in the mean achievement scores of students in the experimental and control groups as measured by MAT, F(1,420) =8.632, *p*=.003. since the obtained p-value is less than the stipulated .05 level of significance, the null hypothesis which stated that there is no significant difference in the mean achievement scores of students in the experimental and control groups as measured by MAT is rejected. This implies that the mean achievement score of students taught Mathematical concept of quadratic equation with interactive jig-saw method is higher than the mean score of those taught with traditional teaching method. This implies that the significant difference is in favour of those taught quadratic equation with interactive jig-saw method of teaching.

Ho2: There is no significant difference in the mean and standard deviation of achievement scores of male and female students taught quadratic equation using interactive jig-saw method and those taught using traditional teaching method.

Table 4: The ANCOVA Results of Achievement Scores of Male and Female Students in the Experimental and Control Group as Measured by MAT.

Source of Variation	Mean Square	Partial Eta Squared	df	F	Sig
GENDER M/F	226.40	.007	1	3.007	.084
TEACHING MTDS JS/TTM	267.120	.009	1	3.835	.051
		421			

The result in Table 13 shown that there is no significant difference in the mean achievement scores of male and female students in the experimental and control groups as measured by MAT, F (1,420) =3.835, p=.051. since the obtained p-value is greater than the stipulated .05 level of significance, the null hypothesis which stated that there is no significant difference in the mean achievement scores of male and female students in the experimental and control groups as measured by MAT is uphold. This implies that the mean achievement score of students taught Mathematical concept of quadratic equation with interactive jig-saw method is the same or slightly different in decimal than the mean score of those taught with traditional teaching method. It indicated that there is no significant difference in achievement among male and female students taught quadratic equation with interactive jig saw method and traditional teaching method.

Discussion of Findings

The study revealed that students taught quadratic equation using interactive jig-saw method achieved more than those taught quadratic equation using traditional teaching method. The finding of the study is inconsonance with Yemi et.al.(2018) who observed that students taught Mathematics concepts of set theorem using interactive jig-saw method achieved better than those taught with traditional teaching method. The study is also in line with Ndukwe and Timayi (2018) who averred that interactive jig- saw increases students' academic achievement among federal collage of education students.

More so, the study revealed a significant different in achievement between students taught quadratic equation using interactive jig-saw method of teaching and those taught with traditional teaching method in favour of those taught with interactive jig-saw. The finding is in line with Yemi et,al (2018), Olanrewaju (2018), Ndukwe and Timayi (2018) who in their different studies observed that there is significant differences between students taught set theorem, number and numeration and computer respectively using interactive jig-saw significantly and taught the same concepts using traditional teaching method in favour of those taught using interactive jig-saw method. The reason for improved academic achievement and significant could be as a result that interactive jig-saw method of teaching allows cohesive collaboration among students during teaching

The result revealed in table 2 shown that male student taught quadratic equation using interactive jig-saw method and traditional teaching method achieved better than their female counterparts in both groups.

The finding is in line with Musa and Samuel (2019) who observed that male secondary school students taught indices at Western Senatorial District of Nasarawa State, Nigeria using interactive jig saw method and traditional teaching method achieved better than their female counterpart. But the finding is not in agreement with Samuel (2018a) who observed that female secondary school students taught basic science in co-education schools in Benue north senatorial zone, Benue State, Nigeria using interactive jig-saw and traditional teaching method, achieved more than their male counterpart though students' taught basic science using interactive jig-saw.

More so the study revealed no significant difference in male and female students taught quadratic equation using interactive jig-saw method and those taught with traditional teaching method. The finding is not in consonance with Samuel (2018a) who maintained that there is a significant difference between male and female students taught basic science using interactive jig-saw method and between male and female taught basic science using traditional teaching method in favour of female students in both teaching methods. But the finding is in line with Areelu et. al. (2018) who did not observe a mean and significant differences in achievement among secondary school students taught Mathematics concept of geometry in Lagos state using interactive jig-saw method and those taught with traditional teaching method. The no significant difference between male and female students taught quadratic equation using interactive jig-saw method and those taught using traditional teaching method could be as result that the students in both groups improved in their academic achievement when taught with these teaching methods.

Conclusion

Based on the findings of this study, the following conclusions were drawn:

The use of interactive jig-saw is more effective for meaningful learning to occur in the Mathematics concept of quadratic equation than traditional teaching method. Secondary school students taught quadratic equation using interactive jig-saw achieved higher than those taught with traditional teaching method. More so, Male students taught with interactive jig-saw and traditional teaching method achieve higher in Mathematic concept of quadratic equation than their female counterpart.

Recommendations

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

1. Mathematics teachers should incorporate interactive jig-saw teaching method as one of the teaching methods in teaching quadratic equation other than traditional teaching method.
2. Teachers should also be encouraged by curriculum planners to employ interactive jig-saw method of teaching to teach quadratic equation calculations to give a wider knowledge to students other than using traditional teaching method.
3. The National Commission for Colleges of Education (NCCE) and Universities should ensure that

students in Mathematics education programmes, lay more emphasis on use of interactive jig-saw method because of its effective role in teaching quadratic equation than traditional teaching method.

4. Ministries of Education, both state and federal should sponsor Mathematics teachers to attend Post graduate programmes. This will ensure that teachers are updated on the use of interactive jig-saw method to improve students' academic achievement than use of traditional teaching method which is teacher centered approach of teaching. This is to help enhance students' academic achievement in Mathematics subject.

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