



EFFECT OF JIGSAW IV COOPERATIVE LEARNING STRATEGY ON SECONDARY SCHOOL STUDENTS' ACADEMIC PERFORMANCE IN GEOMETRY IN KADUNA STATE, NIGERIA

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Abstract

This study investigated the effect of Jigsaw IV cooperative learning strategy on students' academic performance in geometry in Zango Education Zone, Kaduna State, Nigeria. Quasi-experimental research design (i.e. the non-equivalent design which comprises two groups; one is experimental and the other control group) was adopted. Two research questions and two hypotheses guided the study. The population comprised 4,600 SS2 students. The sample was 144 SS 2 students. Multi-stage sampling technique was used. The instrument used to collect data for the study was Geometry Performance Test (GPT) with reliability coefficient of 0.81. Data generated were analyzed using mean and standard deviation to answer the research questions and Analysis of Covariance (ANCOVA) to test the hypotheses at 0.05 level of significance. It was found that there is significant difference in the mean performance scores of students taught geometry using Jigsaw IV cooperative learning strategy and those taught using conventional strategy ($p=0.00<0.05$). Finding further revealed no significance difference in the mean performance scores of male and female students taught geometry using Jigsaw IV learning strategy ($p=0.181>0.05$). Based on the findings it was recommended among others that Mathematics teachers should use Jigsaw IV cooperative learning strategy to ensure effective teaching and learning to enhance students' performance in geometry instead of the use of conventional strategy. Workshops should be frequently organized by educational bodies such as National Teachers Institute (NTI) to sensitize Mathematics teachers on the use of Jigsaw IV cooperative learning strategy for teaching geometry to enhance performance of male and female students.

Keywords: Geometry, Mathematics, Jigsaw IV Cooperative Learning Strategy, Academic Performance

Introduction

One of the greatest legacies laid down for Nigeria by the British colonialists is western civilization to educate and improve the wellbeing of the people. Education is a form of

learning in which the knowledge, skills, values, beliefs and habits of a group of people are transferred from one generation to another generation through storytelling, discussions

teaching, training and research. These could be achieved through the learning of Mathematics.

Mathematics is the study of patterns. It is a systematized, organized and exact branch of science. It is a creation of the human mind, concerned primarily with ideas, processes and reasoning. Mathematics can be seen variously as a body of knowledge, a collection of techniques and strategies, the product of human activity, and even as the activity itself namely the solving of problems (Uloko & Usman, 2018). Mathematics has continued to play a significant role in national development of any country. Adebayo (2017) identifies Mathematics as the ingredient for the effective articulation of the abstract elements of science that gives inputs to the development of technologies. The author further points out that one of the general objectives for Mathematics education is to generate interest in Mathematics and to provide a solid foundation for everyday life. This could be actualized through the study of geometry.

Geometry is a basic and important subject area of school Mathematics and conceptually the basis of branch of mathematics (Cenk & Sevdane, 2013). It is a branch of Mathematics that exploits visual intuition (the most dominant of our senses) to remember theories understand proof, inspire conjectures, perceive reality and give insight (Mbacho & Githau, 2013). Geometry has great importance in people's lives, originating from the needs of human beings to specify quantities, to measure figures, land and earth, and make maps. Geometry is also used in other disciplines such as science (eg optics), geography (e.g. making models), construction architecture, gardening and traffic signs artists, builders, designers and

masons (Mbacho, 2013). The study of geometry contributes to helping students develop the skills of visualization, critical thinking intuition, perspective, problem solving, conjecturing, deductive reasoning, logical argument and proof areas of mathematics, fractions and multiplication in arithmetic and graphical representation of data in statistics.

Despite the relative importance of Geometry in Mathematics, students' performance in the subject in both internal and external examinations has remained consistently poor (Uloko & Usman, 2018). The Chief Examiner's annual reports in Mathematics for Senior School Certificate Examinations (SSCE) conducted by the West African Examinations Council (WAEC) (2018-2021) are good testimonies of the facts that the poor performance is affecting the students and the nation as a whole. The low performance among students in geometry is also observed by Kurumeh, Onah and Mohammed (2022).

Globally, there have been debates on students' performances in Mathematics with respect to gender. A study by Adejo (2015) found that male students performed better than their female counterpart in Mathematics. However, studies such as Uwalaka (2013) and Lawan and Olaji (2019) reported that gender differences were unnoticeable among male and female both performed similarly. In some studies, related to geometry, the same situation and result holds in terms of gender performance. Okoro (2013) submits that male students perform better than their female counterparts by exhibiting better spatial abilities, while Nzewi (2014) found no significant difference at the secondary school level. Iji, Ogbole and Uka



(2014) noted that the girls tend to opt for course that do not take much of their time and are not brain tasking such as home making, while boys opt for science related courses.

The instructional strategy employed by Mathematics teachers could be responsible for the unsatisfactory performance of students in geometry in Kaduna State. It has been observed that mathematics classrooms are predominantly dominated by the conventional teaching strategy of instruction, which does not encourage students-students' interaction. This inhibits development of students' intuition and creative abilities. With the current use of lecture method of teaching Geometry, only very little improvement in students' performance will be achieved. This is because the lecture method of teaching only exposes students to learning with static materials which do not indicate the working principles of various systems. It is also deemed restrictive to some extent and its classroom settings is teacher-centered where the teacher often dominates class discussion and instruction instead of encouraging students' to interact, ask questions or make them understand the lesson thoroughly (Anyichie & Onyedike, 2012). Hence, there is a need to try out other teaching strategies such as Jigsaw IV cooperative learning strategy (CLS).

Jigsaw IV cooperative learning strategy is a strategy that transcends individualization and peer-tutoring to groups of 4-6 participants per group. It has proved to be useful in equipping students with the ability to develop deeper understanding of subject matter (Timayi, Bolaji & Kajuru, 2015). Jigsaw IV cooperative learning strategy includes three important new features: an introduction quizzes, and re-

teaching after individual assessment. The teacher first introduces the lesson by means of lectures, presentation of literature, questioning proposing problems or perhaps showing movies in a 'plenary' class session. Students are then assigned to a heterogeneous group the home group and all students are assigned topics to read. Each student discusses the expert sheet that is based on a list of all topics. Again, the students with the same expert sheet move to their expert group to discuss their topic.

To check accuracy and understanding of students in the expert group, they are assessed by means of a quiz, this being based on the expert sheet. They return to their home group, teach all their group members and take quizzes all based on the original material. The teacher reviews and clarifies any concepts which appears to be challenging for students (Adil, Sameer, Munadhil & Ahamad, 2020). The students take individual quizzes and scores are combined to produce an overall team score. Finally, the teacher re-teaches any material which was misunderstood after the individual assessment process. These features make the Jigsaw IV better than the others (Jigsaw I, II, and III).

There is some empirical evidence that Jigsaw IV teaching strategy has effect on students' academic performance in Mathematics. For example, in a study by Muhamad (2016) who reported that there is a statistical significant difference at the level between the means score performance in favour of the experimental group on achievement and retention. Chianson, Kurumeh and Obida (2011) reported that Collaborative Learning Strategy produces better achievement and retention in students than Convectional Learning Method. Mbacho

and Githua (2013) also discovered from a study that students in the experimental group were found to perform better than those in the control group using the Jigsaw IV cooperative learning strategy. Also, there was no significant gender differences in performance when students were exposed to Jigsaw CLS. Uche (2021) found that the use of Jigsaw IV has significant effect on mean academic achievement of students in Mathematics than the traditional method.

Gambari and Olumori (2013) reported a significant difference in the performance of students in favour of the CLS group. Fini, Zinlipour and Jamri (2012) reported that Jigsaw CLS enhances students' academic performance in Mathematics. Tunde (2015) found that the use of Jigsaw IV has significant effect on achievement of students in Mathematics than the traditional method. Fini, Zainlipour and Jamri (2017) reported that Jigsaw IV CLS has significant effect on students' academic achievement evidenced by the higher mean scores of students as compared to the other students taught same concepts by the traditional method.

The literature reviewed indicates that some research works have been done on effect of Jigsaw IV cooperative learning strategy on academic performance of students in geometry. However; the gap noted was that to the best of researchers' knowledge, very little or no research has been done on Jigsaw IV cooperative learning strategy and students' academic performance in geometry most especially in Kaduna State, Nigeria. As such, this prompted the researchers to carry out this study in order to fill the gap.

Research Questions

1. What is the effect of Jigsaw IV learning strategy on the mean academic performance score of students in geometry?
2. What is the difference in effect of Jigsaw IV learning strategy between male and female students' academic performance in geometry?

Hypotheses

Ho1: There is no significant effect of Jigsaw IV learning strategy on students' mean academic performance in geometry.

Ho2: There is no significant difference in effect between mean academic performance of male and female students taught geometry using Jigsaw IV learning strategy.

Research Method

The research design adopted for this study was the quasi-experimental research design, specifically, the non-equivalent design which comprises two groups, one is experimental and other is control group (CG). This design was adopted because it was not possible to completely randomize the subject into experimental and control group. Intact classes were used in order not to disrupt the existing arrangement of class in the school.

This study was carried out in Zango Education Zone, Kaduna State. The population consisted of 4,600 Senior Secondary Two (SSII) students from the public schools. The sample was 144 (82 male and 62 female) SS 2 students obtained through multi-stage sampling technique. Four co-educational schools were selected using purposive sampling out of nine co-educational schools in Zango Educational Zone for good coverage representation. The choice of co-educational school was because gender was a variable of interest. Two schools each were



selected using simple random sampling of (hat and draw) method and assigned to control and experimental groups.

The instrument used to collect data for the study was Geometry Performance Test. It was developed by the researchers based on units of geometry in the Mathematics curriculum for senior secondary schools prepared by the Nigerian Educational Research and Development Council (NERDC) (2013) and the syllabus of the Senior School Certificate Examinations of WAEC. This covers geometric ratios, triangles and polygons, circle geometry and loci. GPT has two sections: A and B. Section A was for collection of demographic data such as sex of the respondents, while Section B contains 30 multiple choice objective test questions on geometry. Each of these items (five options i.e. A, B, C, D, and E) attracted 1 mark for any correct answer. Eight lesson plans were developed by the researcher on geometry concept to be taught (angles and polygons, intercept, congruent triangles and parallelograms) in accordance with the tenets of cooperative instructional strategy which were used to teach the experimental groups while the control group were taught using lesson plans on the same concepts prepared in line with tenets of the conventional chalk and talk strategy. The concepts are from Senior Secondary II Mathematics curriculum.

In the experimental group, the teacher only acted as a guide to students as they actively engaged in the learning process. The lesson plans for experimental group in this study indicated instructional materials, teachers' and students' activities carried out during the teaching learning process. Specifically, the

lessons were in the following sequence: assessment of assumed previous knowledge, introduction, presentation (teacher and students' activities), whole class cooperative activities, evaluation, summary/conclusion and assignment. The conventional chalk and talk strategy with significant teacher dominance was used to teach the control group. The lesson plans for the control group comprised assessment of assumed previous knowledge, introduction, teachers' and students' activities, evaluation, summary/conclusion and assignment. The research instrument received face and content validity by three experts: two in Mathematics Education and the other a specialist in Measurement and Evaluation. Their criticisms and observation were incorporated into the test items.

In order to determine the reliability of the instruments, the researchers conducted a trial test with a group of 40 students similar to those selected for the actual study. The GPT items were subjected to psychometric analysis and 30 of the items were selected for the study, while 10 were discarded. The reliability of Geometry Performance Test (GPT) was ascertained using the Kuder-Richardson formula 20. Its reliability was found to be 0.81. Base on the number of values considered acceptable. The experimental procedure for data collection was in stages. Two research assistants who were the regular teachers of Mathematics in the sampled schools were selected and trained to aid in data collection. The experimental was conducted in six weeks. The first week was set aside for the administration of the pre-test to both experimental and the control groups. In the same week, the experimental group was taught using Jigsaw IV cooperative learning strategy,

while the control group was taught using traditional learning strategy. At the end of the treatments, a post test was administered to each group. The result of the pre-test and posttest were marked and compiled for analysis. Data generated were analyzed using mean and standard deviation to answer the research questions and Analysis of Covariance (ANCOVA) to test hypotheses at 0.05 level of significance. The decision rule was that null

hypotheses were rejected if the p-value was less than 0.05 and not rejected if otherwise.

Results

Research Question One

What is the effect of Jigsaw IV on the mean academic performance scores of students in geometry?

Table 1: Mean and Standard Deviation on Students' Academic Performance taught Geometry using Jigsaw IV Learning Strategy and Conventional Learning Strategy

Group	n	Pretest		Posttest		Mean gain
		Mean	Std. D.	Mean	Std. D.	
Jigsaw IV	73	8.03	1.563	23.07	1.686	15.05
Conventional	71	7.03	1.512	10.69	1.582	3.66
Mean Difference		1.00		12.38		11.39
Total	144					

Table 1 reveals that the mean academic performance scores of students taught Geometry using Jigsaw IV learning strategy was 8.03 with standard deviation of 1.563 at pre-test. It also shows mean value of 23.07 with standard deviation of 1.686 in the post-test. The mean performance of students taught Geometry using conventional learning strategy was 7.03 with standard deviation of 1.512 during pre-test. It also shows mean value of 10.69 with standard deviation of 1.582 in post-test. The mean gain of students taught

Geometry using Jigsaw IV learning strategy was 15.04, while those taught using conventional learning strategy had a mean gain of 3.66. The mean difference between the two teaching methods was 11.38 in favour of Jigsaw IV cooperative learning strategy.

Research Question One

What is the difference in effect of Jigsaw IV strategy between male and female students' academic performance in geometry?



Table 2: Mean and Standard Deviation score of Male and Female Students’ Academic Performance taught Geometry using Jigsaw IV Learning Strategy

Gender	N	Pretest		Posttest		Mean gain
		Mean	Std. D.	Mean	Std. D.	
Male	40	7.85	1.442	23.30	0.564	15.45
Female	33	8.24	1.696	22.79	2.421	14.55
Mean Difference		0.39		0.51		0.9
Total	73					

Table 2 indicates that the mean academic performance scores of male students’ taught Geometry using Jigsaw IV cooperative learning strategy was 7.85 with standard deviation of 1.44 2 at pre-test. It also shows mean value of 23.30 with standard deviation of 0.564 in post-test. The table also indicates that the mean academic performance scores of female taught Geometry using Jigsaw IV learning strategy was 8.24 with standard deviation of 1.696 at pre-test. It also shows mean value of 22.79 with standard deviation of 2.421 in post-test. The

mean gain of male students taught Geometry using Jigsaw IV learning strategy was 15.45, while that of female students was 14.55. The mean difference male and female was 0.90 which is small in favour of male students taught Geometry using Jigsaw IV learning strategy.

Hypothesis One

There is no significant effect of Jigsaw IV learning strategy on students’ mean academic performance in Geometry.

Table 3: ANCOVA Result of Difference in Mean Academic Performance of Students taught Geometry using Jigsaw IV Cooperative Learning Strategy and Conventional Learning Strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5515.202 ^a	2	2757.601	1024.227	.000	.936
Intercept	1658.888	1	1658.888	616.143	.000	.814
Pretest	.216	1	.216	.080	.777	.001
Strategy	5002.371	1	5002.371	1857.978	.000	.929
Error	379.625	141	2.692			
Total	47341.000	144				
Corrected Total	5894.826	143				

a. R Squared = .936 (Adjusted R Squared = .935)

Table 3 reveals that $F(1, 141) = 1857.978$; $p=0.000 < 0.05$. Thus, the null hypothesis is rejected. This implies that, there is significant difference in the mean academic performance scores of

students taught geometry using Jigsaw IV cooperative learning strategy and those taught using conventional learning strategy. Thus, based on partial eta squared value of 0.929, it implies that 92.9% of students' performance can be attributed to the teaching strategy used.

Hypothesis Two

There is no significant difference in effect on academic performance between male and female students taught Geometry using Jigsaw IV learning strategy.

Table 4: ANCOVA Result on Difference in Mean Academic Performance Scores between Male and Female Students taught Geometry using Jigsaw IV learning Strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5.644 ^a	2	2.822	.993	.376	.028
Intercept	1301.491	1	1301.491	457.780	.000	.867
Pretest	.902	1	.902	.317	.575	.005
Gender	5.198	1	5.198	1.828	.181	.025
Error	199.013	70	2.843			
Total	39052.000	73				
Corrected Total	204.658	72				

a. R Squared = .028 (Adjusted R Squared = .000)

Table 4 reveals that $F(1, 70) = 1.828$; $p=0.181 > 0.05$. Since $p > 0.05$, the null hypothesis is therefore, not rejected. Hence, there is no significant difference in effect on academic performance between male and female students taught Geometry using Jigsaw IV learning strategy. Based on partial eta squared value of 0.025, it implies that 2.5% of students' academic performance could be accounted for by gender when Jigsaw IV cooperative learning strategy was used.

Discussion of Findings

Findings of this study indicated a significant difference in the mean performance scores of students taught Geometry using Jigsaw IV cooperative learning strategy and those taught using conventional approach. This finding is in conformity with Muhamad (2016) who found that there is a statistical significant

difference between the means score performance in favour of the experimental group using Jigsaw IV learning strategy. The finding also confirms Mbacho and Githua (2013) who found that students in the experimental group using Jigsaw IV learning strategy performed better than those in the control group. The finding also agrees with Mari and Gumel (2015) who reported that the use of cooperative learning strategy (CLS) has significant effect on the academic achievement of formal 'reasoners' more than that of the concrete 'reasoners' and students with formal reasoning were more enhanced in their academic achievement than those with concrete reasoning when exposed to the cooperative learning strategy.

Furthermore, the result agrees with Fini, Zinlipour and Jamri (2012) who found that Jigsaw IV CLS has significant effect on



students' academic achievement evidenced by the higher mean scores of students as compared to the other students taught same concepts by the traditional strategy. This finding is due to the fact that Jigsaw IV strategy makes learning fun as students co-learn and share ideas which fosters improvement in students' performance in geometry.

Finding further revealed no significance difference in the mean performance scores of male and female students taught Geometry using Jigsaw IV learning strategy. This finding is in agreement with Mbacho and Githua (2013) who found that both male and female students benefitted equally when taught using collaborative learning approach in Social Studies. Also, the finding aligns with Ayomi and Tokpe (2018) who found no significant gender differences in performance when students were exposed to Jigsaw CLS.

The consistency in these findings could be attributed to the fact that Jigsaw IV collaboration is instrumental method of interaction where individuals are responsible for their actions irrespective of gender. Collaboration during learning of geometry is a structure of interaction designed to facilitate and accomplish specific end product or goal through people working together in groups. It aims at getting the students to take almost full responsibility for working together, building knowledge together, changing and evolving together and of course improving together which could bridge the gap in students' performance based on gender.

Conclusion and Recommendations

The findings of this study led to the conclusions that Jigsaw IV cooperative learning strategy is capable of enhancing performance of students in geometry. Furthermore, the findings in this study revealed that Jigsaw IV cooperative learning strategy is efficacious in eliminating gender related differences in performance in Geometry learning. Based on these findings, it was recommended that:

1. Mathematics teachers should use Jigsaw IV cooperative learning strategy to ensure effective teaching and learning so as to enhance students' performance in geometry instead of the use of conventional approach.
2. Workshops should be frequently organized by educational bodies such as National Teachers Institute (NTI) to sensitize Mathematics teachers on the use of Jigsaw IV cooperative learning strategy for teaching geometry to enhance performance of male and female students.

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