International Journal of Science Academic Research
Vol. 05, Issue 12, pp.8827-8832, December, 2024
Available online at http://www.scienceijsar.com

ISSN: 2582-6425

Research Article

EFFECTS OF JIGSAW AND GEOBOARD INSTRUCTIONAL STRATEGIES ON GEOMETRY STUDENTS' ACHIEVEMENTS IN DELTA STATE

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Received 24th October 2024; **Accepted** 18th November 2024; **Published online** 27th December 2024

Abstract

Effects of Jigsaw and Geoboard Instructional Strategies on geometry Students' Achievements in Delta State was investigated in this study. Two research questions and two hypotheses were formulated to guide this study. The study adopted the quasi-experimental (non- randomized, pre-test, post-test, planned variation) design. The population of the study consisted of 18,879 SSII mathematics students in 435 public secondary schools in Delta State. The sample for the study consisted of 289 SSII students drawn from six public mixed secondary schools, using simple random sampling. Two from each of the three Senatorial Districts of the state. Instrumentation for the study was done with a Geometry Achievement Test (GAT), Data obtained from the instruments were analyzed using: mean, standard deviation, T-test, Analysis of Variance (ANOVA), Findings from the results showed that Jigsaw teaching, Geoboard strategy and Lecture method have significant effects on students achievement, in favour of Jigsaw teaching and Geoboard strategy. Based on the findings of this study, it was recommended that mathematics teachers in secondary Schools should adopt a better method of teaching mathematics (such as Jigsaw teaching and Geoboard strategy), to enhance students involvement in the teaching/learning process, as this will inturn result in better academic achievement by the students. Also, Government, on its part, should provide more funding and infrastructures to schools, so that there will be enough labs and instructional materials to engage students in task-base teaching methods.

Keywords: Jigsaw, Geoboard, Instructional Strategies, Geometry, Students' Achievements, Delta State.

INTRODUCTION

Geometry is the branch of Mathematics that deals with shapes and space. Betiku (2000) views geometry as the science of space which describes and relates with shapes. Betiku continued by stating that basic geometry allows students to determine properties such as the areas and perimeters of two dimensional shapes, and surface areas and volumes of three dimensional shapes. Geometry is of great importance, it improves knowledge and helps students to think logically. (Obi, 2014). The knowledge of geometry helps in the understanding of other areas of Mathematics. Geometrical interpretations provide useful and initiative understanding of most areas of Mathematics and geometrical techniques provide tools for solving problems in other areas of Mathematics. (Odili 2006) In support of this, Agwagah (2008) opined that, knowledge of shapes, numbers, and operations on the shapes help to describe and predict things about the world around us.

The benefits of geometry to every individual and the society are numerous (Idu, 2004). It should be of note that the application of geometry cuts across all facets of human endeavours, which includes; surveying, architecture, engineering aviation etc. The application of geometry to aviation dated back to five thousand years ago by the Egyptian surveyors with the skills of measurement of lengths, areas, angles, bearing and Pythagorean triple. Despite the importance of geometry and its usefulness in everyday life as an aspect of Mathematics, students still perform poorly in mathematics particularly in geometry (Akpokiniovo, 2022). This corresponds to WAEC chief examiner's report of (2018 - 2020) where geometry was rated least in the performance of students followed by algebra.

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Students' main weakness according to the Chief Examiners report is a lack of basic understanding of geometrical concepts, which can be traced back to students' memorization of geometrical concepts as a result of poor teaching methods used by Mathematics teachers at the secondary school level. The lecture method of instruction is a teacher-centred approach in which the teacher passes on knowledge in its ultimate form to the students. The students pay attention to the teacher and are rarely given the opportunity to ask questions as the course develops. According to Akpokiniovo (2018), a lecture is an address, a discussion, a lesson, or other sorts of verbal presentation by a teacher to students. Under the leadership of the teacher, the students take charge of their own learning having a good attitude towards the subject. Jigsaw and Geoboard seems to enhance students' achievements in geometry. Jigsaw is a teaching strategy invented by social psychologist Elliot Aronson in 1971. As stipulated by Adams, students in an average class of about 26 to 33 are subdivided into subgroups of about 4 to 6 students per group, where each group is to research on a particular segment of the lesson content. Individual members of the groups further breaks out to form expert groups. Members of an expert group are to solve one aspect of the lesson content being learned. Based on Adam's work, Students of an average class sized (26 to 33 students) are divided into competency groups of four to six students to research. Individual members of each group then break. Thereafter, members of the expert groups return to their original group to teach what they have learned in the expert group (Binabo, 2013). Jigsaw instructional strategy according to Danladi (2010) is a method of organizing classroom learning in such a way that lesson contents are broken down into pieces, and the class subdivided into groups of about three to five students depending on the class size, and students are dependent on each other to complete the jigsaw puzzle. In this strategy of learning, Ojekwu, & Ogunleye (2020) opined that there is great collaboration among students, who work together as a team or group with mixed abilities. Some scholarly researches has shown that students perform better in their subjects when taught with the jigsaw instructional strategy. However, there is need to also examine the use of geoboard as another student-centred teaching strategy. Geoboard is a peace of wooden device consisting of rows and columns of protruding nails, usually in a square or rectangular shape. Geoboard is a short form for geometrical board. According to Abari and Andrew (2021), Geoboard as a manipulative that is used to support learning of geometry, measurement and numeracy. A Geoboard is made up of piece of wood and some nails. It can be used to demonstrate the properties of plane shapes, it is also useful in the study of area and perimeter of plane shapes. Olajide, Ekwueme and Ndioho (2020) also describes Geoboard as a rectangular board with nails nailed into its surfaces in such a way, with equal intervals in between. Rubber bands and threads are used to connect the number of nails needed to form appropriate concept(s) such as perimeters and lengths, in using the geoboard for the teaching of geometry. Okechukwu and Eze (2019) looked into how Geoboard affected the geometry proficiency of junior secondary school pupils. The findings show that using Geoboard to help children succeed in geometry is better than using the traditional method. Additionally, there is no discernible difference in the Geoboard technique.

Statement of the Problem

According to an analysis of Chief Examiner's reports from the West African Examination Council (WAEC) from 2018 to 2020, student performance in geometry is decreasing, with the poorest score recorded in 2020. Students' poor academic performance in WASSCE has been attributed to a lack of comprehension of basic mathematical topics, which could be due to mathematics teachers' use of teacher-centred teaching methods, particularly the lecture method. The use of the lecture method is believed to have made students in Nigerian secondary schools have resorted to memorizing of mathematics principles as a result of their passive involvement in the teaching and learning process. This calls for the adoption of students-centred teaching methods such as jigsaw teaching and geobaord instructional Strategies that gives students opportunity to set goals for their learning, perform learning task(s) and attempts to monitor, regulate and control their cognition and have a better attitude towards geometry. Furthermore, literature is replete with the unresolved status of the sex of the students in geometry achievement and attitude. Hence, the problem of this study is: What is the effect of jigsaw and geoboard teaching strategies on male and female students‟ achievement in geometry? The question gives rise to the study.

Research Questions

The following questions were formulated to direct this study:

1. What is the effect of jigsaw, geoboard instructional strategy and lecture method on students‟ achievement in Geometry?
2. What is the difference in the Geometry mean achievement scores among students taught with jigsaw, geoboard instructional strategy and lecture method?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

1. HO_1 There is no significant effect of jigsaw, geoboard instructional strategy and lecture method on students‟ achievement in Geometry.
2. HO_2 There is no significant difference in the Geometry mean achievement scores among students taught with jigsaw, geoboard instructional strategy and lecture method

Methods of the Study

The study adopted quasi-experimental design. Specifically, the pretest, posttest planned variation design was used. In this design, random assignment of subjects to experimental and control groups was not used rather intact class was used in order not to disrupt classroom teaching. The population of the study will comprise all public Senior Secondary School Mathematics students in Delta State. Specifically, the study population consists of 18,879 SSII Mathematics students in public Secondary Schools in Delta State. A sample of two hundred and eighty nine (289) SSII Mathematics students selected from six (6) public mixed senior secondary schools in Delta State was used as the sample size for this study. Simple random sampling technique was used to select the 6 schools. Specifically, the researcher randomly selected two schools each from the three Senatorial Districts of Delta State.

The instruments used for data collection in this study are: (a) Geometry Achievement Test (GAT) constructed by researcher from a six weeks instructional unit in Geometry on: (i) Rectangle (ii) Square (iii) Parallelogram and (iv) trapezium (See Appendix II, III & IV); and (b) Geometry Attitude Questionnaire (GAQ). The Geometry Achievement Test (GAT) consists of 50 multiple choice test items constructed from the six weeks instructional units. The reliability of the Geometry Achievement Test (GAT) was established using the Kuder-Richardson formula 21. On analysis, a reliability coefficient value of 0.86 was obtained.

The treatment lasted for a period of six weeks. A week before the start of treatment the researcher distributed the instructional units for both experimental and variation groups to the six research assistants (Mathematics teachers). The instructional units contained some selected Mathematics concepts which include; (i) Rectangle (ii) Square (iii) Parallelogram and (iv) trapezium drawn from New General Mathematics. The distribution of instructional units is; (i) to familiarize the teachers with the subject matter contents and (ii) to ensure that all the instructional presentation followed the recommended format for the designated classes. Two days before the start of treatment, both the experimental and control groups were pretested with the 50 items Mathematics Achievement Test (MAT) and 20 items Mathematics Attitude Questionnaire (MAQ). This was carried out to determine the equivalence of the groups before treatment and be sure that any noticed change later is due to treatment. On treatment for the control group, each and all the contents in the six week instructional unit were presented to the students using lecture method. In the experimental classrooms where jigsaw instruction and geobaord instructional strategies were applied, the following activities were performed.

The Actual Treatment for the Jigsaw Strategy

The actual training from this group followed the 10 steps of using jigsaw instructional strategy as recommended by Aronso (2008):

- Introduce the topic to be studied by giving a brief explanation of the technique to the students and summarizing the topic.
- Randomly assign each student to a home group of 3-5 depending on the class size and ensure that the group differs in mental ability, sex, ethnicity.
- Divide the day"s lesson into segment and assign one segment to each student in the home group.
- Provide materials and resources necessary for all students to learn about their topic and become experts.
- Allot some time for the students to master their own segment of the lesson..
- Create temporary "expert group" that consist of students across "home group" who read the same segment.
- Give the guidelines for students to reconvene into their "home group" and provide the rules as each "expert" reports what they have learned.
- Give allowance of time for students in the expert groups to highlight the main points of their segment and to practice the aspects of the lesson to be thought to their home group.
- Bring students back into their home groups.
- Allow the students to present his or her segment to the home group. Create room for questioning in other for clarity.

The Actual Treatment for the Geobaord instructional Strategy

The following procedure was followed in the treatment of the geoboard instructional strategy. The teachers in the geoboard learning group incorporated the four sequence phases: task perception; goal setting and planning; enacting phase and adaptation phase.

Task perception on Geoboard: Teacher guided the learner to identify problem and assembled information about the task at hand and take the responsibility.

Goal setting and planning: Students focused on how to succeed in the task. This involved stating goals out of the task perceived. The goals stated guided the student to make plans to actualize the stated goals by utilizing study skills and other tactics in learning.

Enacting phase: Enacting phase is the processing stage of geoboard where all the planning is carried out in focus to already stated goals. It is the stage of rigorous activities, action and reaction for the purpose of achieving the stated goals.

Adaptation phase: Is the last phase consisting of the evaluation of performance and observing the loopholes to modify so as to have greater performance in future. The stages are followed step-by-step intensively by students which lead to sure success in academics.

At the expirations of the six weeks treatment, students in both experimental and control groups were post-tested with the 20 items MAQ and 50 items MAT after re-shuffling the items and scored. Students" scores in the experimental and control groups from the pretest and posttest was collated, analysed and compared in a bid to ascertain the effects of jigsaw teaching and Geobaord instructional Strategies on Mathematics students' achievement.

Data Analysis

Descriptive statistics as was used as method of data analysis in order to answer the research questions raised. This involved the use of mean and standard deviation. The testing of null hypotheses involved the use of t-test and Analysis of Variance (ANOVA). Hypothesis testing was done at 0.05 level of significance.

RESULTS AND DISCUSSION

The results are tabulated and interpreted immediately after each table according to the research questions and corresponding hypotheses.

Research Question One: What are the effects of jigsaw, geoboard instructional strategy and lecture method on students' achievement in Geometry?

Table 1. Mean and standard deviation of pretest and posttest achievement scores among students taught geometry using jigsaw geoboard instructional strategy and lecture method

Group	N	Pretest Mean	SD	Posttest Mean	SD	Mean Difference
Jigsaw teaching strategy	99	22.98	4.23	67.39	9.56	44.41
Geoboard teaching strategy	97	22.48	4.76	64.66	7.19	42.18
Lecture	93	22.10	6.34	56.22	7.94	34.12
Total	289					

The data in Table 1 shows a pretest mean achievement scores of 22.98, 22.48 and 22.10 and standard deviation of 4.23, 4.76 and 6.34, for students in the jigsaw teaching strategy, geoboard instructional strategy and lecture method groups. A higher posttest mean achievement scores of 67.39, 64.66 and 56.22, and standard deviation of 9.56, 7.19 and 7.94, respectively for students in the jigsaw, geoboard instructional strategy and lecture method groups. The observed increment of 44.41, 42.18 and 34.12, for students in the jigsaw, geoboard instructional strategy and lecture method groups is not due to chance rather as a result of treatment. This implies that the both jigsawand geoboard instructional strategies have effect on students' achievement in geometry.

Hypothesis One: There is no significant effect of jigsaw, geoboard instructional strategy and lecture method on students' achievement in Geometry

Table 2 indicates a significant effect of Jigsaw teaching strategy ($t = 47.01$, $P(0.00) < 0.05$), Geoboard strategy ($t = 46.68$, $P(0.00) < 0.05$), and lecture method ($t = 34.30$, $P(0.00) < 0.05$) on achievement.Therefore, Ho_1 was rejected. Thus, there is a significant effect of jigsaw, geoboard instructional strategy and lecture method on students' achievement in Geometry.

Research Question Two: What is the difference in the Geometry mean achievement scores among students taught with jigsaw, geoboard instructional strategy and lecture method?

Table 2. T-test comparison of pretest and posttest mean achievement scores of students taught geometry using jigsaw, geoboard instructional strategy and lecture method

Group	N	Pre-test Mean	SD	Posttest Mean	SD	df	t-cal	sig. (2-tailed)	Remark
Jigsaw	99	22.98	4.23	67.39	9.56	98	47.01	0.00	Ho_1 is rejected
Geoboard	97	22.48	4.76	64.66	7.19	96	46.68	0.00	
Lecture	93	22.10	6.34	56.22	7.94	92	34.30	0.00	
Total	289								

P<0.05

Table 3. Mean and standard deviation of pretest and posttest achievement scores among students taught geometry using jigsaw teaching strategy, geoboard strategy and lecture method

Group	N	Pretest		Posttest		Mean Difference
		Mean	SD	Mean	SD	
Jigsaw	99	22.98	4.23	67.39	9.56	44.41
Geoboard	97	22.48	4.76	64.66	7.19	42.18
Lecture	93	22.10	6.34	56.22	7.94	34.12
Total	289					

Table 4. ANOVA comparison of pretest scores of students taught with jigsaw strategy, geoboard strategy and lecture method

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	37.685	2	18.842	.707	.494
Within Groups	7620.315	286	26.644		
Total	7658.000	288			

P>0.05

Table 5. ANOVA comparison of posttest scores of scores of students taught with jigsaw strategy, geoboard strategy and lecture method

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6455.653	2	3227.826	46.839	.000
Within Groups	19709.108	286	68.913		
Total	26164.761	288			

P<0.05

Table 6. Scheffe's Post-Hoc test to compare jigsaw strategy, geoboard strategy and lecture groups on students' achievement

Dependent Variable	(I) Instructional strategies	(J) Instructional strategies	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Achievement posttest scores	Jigsaw instruction	Geoboard Strategy	2.734	1.186	.072	-.18	5.65
		Lecture	11.179*	1.199	.000	8.23	14.13
	Geoboard	Jigsaw instruction	-2.734	1.186	.072	-5.65	.18
		Lecture	8.445*	1.205	.000	5.48	11.41
	Lecture	Jigsaw instruction	-11.179*	1.199	.000	-14.13	-8.23
		Geoboard Strategy	-8.445*	1.205	.000	-11.41	-5.48

*. The mean difference is significant at the 0.05 level.

The data in Table 3 shows a pretest mean achievement scores of 22.98, 22.48 and 22.10, for students taught geometry using jigsaw, geoboard instructional strategy and lecture method. This implies that all the groups were at equivalent on the knowledge of the geometry before treatment by mere comparison of the means. For the posttest, the experimental groups (jigsaw, and geoboard instructional strategy) obtained a higher mean achievement score of 67.39, with a standard deviation of 9.56, for jigsaw teaching strategy and a mean achievement score of 64.66, with a standard deviation of 7.19, for geoborad strategy. The control group (lecture method) obtained a mean achievement score of 56.22, with a standard deviation of 7.94. Table 3showed that students taught geometry with jigsaw strategy scored the highest marks followed by students taught with geoboard and lecture method respectively.

Hypothesis Two: There is no significant difference in the Geometry mean achievement scores among students taught with jigsaw, geoboard instructional strategy and lecture method

The ANOVA comparison of the groups as shown in Table 4 indicated non-significant difference, F (2, 286) = 0.707, P(0.494) > 0.05. This implies that there is no significant difference in the pre-test scores of the three groups compared. Hence, the hypothesis was tested with ANOVA. A significant difference was found between the group taught with jigsaw strategy, geoboard strategy and lecture method as shown in Table 10, F (2, 286) = 46.839, P(0.000) < 0.05.

Therefore the null hypothesis was rejected. Thus, there is a significant difference in the geometry mean achievement scores among students taught with jigsaw strategy, geobaord strategy and lecture method. The Scheffe's post-hoc analysis shows that there is a significant difference between the mean achievement scores of students taught geometry with jigsaw strategy and those taught with geoboard strategy, in favour of jigsaw strategy. There is also a significant difference between the mean achievement scores of students taught geometry with jigsaw strategy and those taught with lecture method, in favour of jigsaw teaching strategy. There is also a significant difference between the mean achievement scores of students taught geometry with geoboard strategy and those taught with lecture method, in favour of geoboard strategy. Table 5 shows that out of the three methods, jigsaw strategy proved most effective.

DISCUSSION

The study revealed that there is a significant effect of jigsaw teaching strategy, geoboard strategy and lecture method on students' achievement in geometry. This is evident on the higher posttest achievement scores of students taught geometry with jigsaw teaching strategy, geoboard strategy and lecture method as shown in Table 2. As shown in Table 2, students' posttest achievement scores greatly increased after treatment compared to their pretest achievement scores. This increment is as a result of treatment with the use of jigsaw teaching strategy, geoboard strategy and lecture method. Therefore, it can be concluded that jigsaw teaching strategy, geoboard strategy and lecture method have significant effect on students' achievement in geometry. The study again revealed that there is a significant difference in the geometry mean achievement scores among students taught with jigsaw teaching strategy, geoboard strategy and lecture method, in favour of jigsaw teaching strategy, followed by geoboard strategy and lecture method. Jigsaw teaching strategy and geoboard strategy proved more effective than the lecture. The difference in the mean achievement scores among the three groups may be as a result of the different teaching methods adopted in each group.

The teaching methods adopted may have enhanced students' learning in geometry more than the other. As indicated in Table 5, students taught geometry with jigsaw teaching strategy and geobaord strategy outscored those taught with lecture method. This suggests that students in jigsaw teaching and geoboard groups may have been more active during the teaching and learning process which contributed to the higher achievement scores. The low achievement scores of students in the lecture group is as a result of the passive involvement of students during the teaching and learning process since teachers pass their knowledge to students using the conventional teaching method. This finding supports that of Ojekwu, &Ogunleye (2020) carried out a study to determine the effects of jigsaw learning strategy on science students' performance and interest in Biology in selected schools in Rivers State, Nigeria. The results showed that there was a significant difference ($P<0.05$) in the performance and interest scores of the science students in the experimental and control groups. Students who received instruction using the Jigsaw strategy improved their mean scores more than those who received instruction using the traditional lecture method in both instances.

This finding agrees with the views of Danladi (2010) carried out a study on the effect of Jigsaw instructional strategy on students' performance in contents in senior secondary school biology. The result of the study showed that Jigsaw instructional strategy has significant effect on students' performance in contents in senior secondary school biology. The study recommended regular use of Jigsaw instructional strategy in the teaching of contents in biology. This finding also agrees with that of Binabo (2013) conducted a study on the effect of Jigsaw instructional strategy on students' interest in Geometric in mathematics. The major finding of the study was that Jigsaw instructional strategy has significant effect on students' interest in Geometric in mathematics. Furthermore, on the area of geoboard, the finding of the study corroborate the work of Abari and Andrew (2021) carried out a study on the impact of Geoboard on junior secondary school geometry students' performance in Makurdi City of Benue State.The findings show that using Geoboard to teach geometry is more effective than using lectures in terms of improving students' performance. Furthermore, there is no discernible difference in the mean geometry performance of boys and females when using the Geoboard technique. Finding of the study also concurred to the work of Olajide, Ekwueme and Ndioho (2020) who examined geobaord application on the academic achievement of senior secondary school pupils in the Degema local government region of Rivers State and the teaching of geometry. The results demonstrated the usefulness of the Geoboard technique in offering sufficient structure for in-depth study of real-world tasks that result in significant comprehension and, consequently, improve performance in geometry, which senior secondary school pupils found challenging. Additionally, it proved that Geoboard is a highly successful method for raising pupils' geometry proficiency. Similarly, Okechukwu and Eze (2019) looked into how Geoboard affected the geometry proficiency of junior secondary school pupils. The findings show that using Geoboard to help children succeed in geometry is better than using the traditional method. Additionally, there is no discernible difference in the Geoboard technique.

Conclusion/Policy Recommendation

Based on the findings generated thus far, the study conclude that jigsaw teaching strategy augments students' achievement in geometry than the lecture method. Goeboard instructional strategy enhance students' achievement in geometry than the lecture method. The researcher therefore recommend that the use of jigsaw and geoboard instructional strategies by mathematics teachers during classroom instruction at the secondary school level should be adopted to ensure students active involvement. Mathematics teachers should attend workshops to get acquainted with innovative instructional strategies. And Government should provide adequate infrastructural facilities and instructional materials to ensure effective implementation of innovative instructional strategies during instruction at the secondary school level.

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