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# EFFECTS OF JIGSAW IV COOPERATIVE LEARNING STRATEGY ON STUDENTS' PERFORMANCE AND RETENTION IN GEOMETRY AMONG SECONDARY SCHOOL STUDENTS IN ZARIA METROPOLIS, KADUNA STATE, NIGERIA

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## Abstract

*This study examined the effects of Jigsaw IV Cooperative Learning Strategy (J4CLS) on Students' Performance and Retention in Geometry among Secondary School Students in Zaria Metropolis. A pretest, Posttest and Post Posttest Quasi-experimental research design was used for the study. The experimental group was exposed to J4CLS while the control group was taught using Conventional Method of Teaching. Sample size of students were selected from two Senior Secondary Schools in Zaria Metropolis were used as the study sample, drawn from a population of 15 schools. The two schools selected, were pretested to find their academic status before the treatment. An Instrument was developed named Geometry Performance Test (GPT) with reliability coefficient of 0.79 using SPSS. The Concept of Geometry discussed in this study was plane geometry (2-D Geometry). The data collected were analyzed using Mean scores, Standard deviation and t-test at* $\propto = 0.05$ *level of significance. There is significant difference in the mean scores of Secondary students taught 2-D Geometry concepts with J4CLS and their counterparts taught with Conventional Method of Teaching in the Metropolis. Students exposed to J4CLS performed higher than those exposed to Conventional Method of Teaching. Students exposed to J4CLS had retained 2-D Geometry concepts higher than those taught using Conventional Method of Teaching. Based on the findings, it was recommended among others that, Mathematics teachers should integrate J4CLSinto main streams of pedagogy in the teaching at Senior Secondary Schools.*

**Keywords**: JIGSAW IV Cooperative Leaning Strategy, Performance, Retention, 2-D Geometry.

## Introduction

Mathematics (from Greek word "mathema" knowledge, study, and learning") is the Quantity, Structure, Space and Change. Galileo Galilea (1564-1642) said, "The universe cannot be read until we have learnt the language and become familiar with the characters in which it is written. It is written in Mathematical Language and the letters are Triangles, Circles and other Geometrical Figures, without these, one would be wondering about in a dark muddle. In contemporary Education, Mathematics Education is the practice of teaching and learning Mathematics along with the associated scholarly research (Tudunkaya & Jamilu, 2019).

Geometry is a branch of mathematics that deals with the study of plane shapes (2-D geometry) and solid shapes (3-D geometry). Geometry as one of the two fields of pre-modern mathematics, the other being the study of numbers. Geometry from the Ancient Greek; geo "earth", -metro "measurement" arose as the field of knowledge dealing with 2-

D and 3-D relationships. Classic geometry was focused on compass and straightedge construction. Geometry was revolutionized by Euclid who introduced mathematical rigor and the axiomatic rigor still in use today. In modern times, geometric concepts have been generalized to a high level of thought and complexity, and have been subjected to the methods of calculus and abstract algebra, so that many modern branches of the field are barely recognizable as the descendants of early geometry (Tudunkaya & Jamilu, 2019). Inekwe (2005) opined that, geometry receives a general disfavor among secondary school students. Numerous studies have shown that geometry is of great important than most areas of Mathematics and also, helps students to understand and love Mathematics (Julie, 2015). Geometry is any shape seen as a set of specific set points, while a plane means a collection of all lines (Pereira *et al*., 2021). Geometry is highly important so much so that, engineers apply its knowledge in construction of houses, cars, chairs and almost all equipment we use in our day to day activities.

The earliest recorded beginnings of geometry can be traced to early populates, who discovered obtuse triangles in the ancient Indus Valley, and ancient Babylonia from around 3000 BC. Early geometry was a collection of empirically discovered principles concerning lengths, angles, areas, and volumes, which were developed to meet some practical need in Surveying, Construction, Astronomy, and Various crafts. Among these were some surprisingly sophisticated principles, and a modern mathematician might be hard put to derive some of them without the use of calculus. For example, both the Egyptians and the Babylonians were aware of versions of the Pythagorean Theorem about 1500 years before Pythagoras and the Indian Sulba Sutras around 800 B.C. contained the first statements of the theorem; the Egyptians had a correct formula for the volume of a frustum of a square pyramid. Adetula (2002), sees it as a tool which helps in logical reasoning with meaningful inference. Adekola (2010), views geometry as the branch of mathematics that deals with the study of shapes both planes and solids. Geometry questions during mathematics examinations were not well attended thus, students do skip geometry questions in the examination (Sambo, 2015). Sambo (2015), stated that, these abilities to make logical reasoning and deductions helps individuals in coining solutions both individual and societal challenges which helps in nation's building. Geometry is one of the key topics in mathematics which, its knowledge is being applied in many vocations across the globe (Sam & Salman, 2016). It is also, one of the major topics in the senior secondary school mathematics curriculum. The knowledge of geometry is crucial in many fields of human life like Engineering. Geometry helps in logical thinking.

Jig-saw (IV) Cooperative Learning Strategy is based on the theory of Constructivism, Peer learning theory of Piaget (1969) and social learning theory of Vygotsky (1978). The constructivism, is a school of thought that believes in learners actively constructing their own knowledge and understanding using previous knowledge and interacting with instructional materials under the guidance of the teacher. Constructivism is a theory based on observation and scientific study about how people learn (Fosnot, 1996). It says that, people construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences. When we encounter something new, we have to reconcile with our previous ideas and maybe changing what we believe, or maybe discarding the new information as irrelevant. In any case, learners are active creators of their own knowledge. Constructivist such as Piaget (1977) and Bruner (1996) believe that individuals actively construct their own knowledge by comparing new ideas or concepts with their current knowledge. In Jigsaw (IV) cooperative learning strategy also, students are actively involved in constructing their own understanding and

knowledge of the concepts based on the previous experience acquired and reflecting on those experiences through active participation in the lesson.

The peer learning theory of Piaget, (1969) believed that, learning improved with the help of peers. Piaget found that, children need to discuss their findings as well as having stimulating environment in which they learn in peers. Learners need to be active, have hands-on opportunities, and not to become the least passive as the case may often be. He thought peer interaction could help students to recognize contradictions and interpretation of a problem. The dialogue creates cognitive gains and allowed students have a relationship built on cooperation. Piaget opined that teachers should create an enabling environment of mutual respect such as that of Jig-saw (IV) Cooperative Learning Strategy where learners works in peer and shared the knowledge acquired so as to ensure meaningful learning and mastery of the lesson. The entire group depended on the other member of the group for success. Therefore, this theory supports the use of J4CLS in Science Education.

Vygotsky (1978), in his Social Cognitive Theory, reflected the structure of Jig-saw Cooperative Learning in learners. Vygotsky believed that infant were born with some level of social-cognitive ability. This ability would have enhanced as long as the children grew-up with understanding and supportive adults who encouraged their verbalization and permitted collaborative conversations. He theorized that, as learners grow, they experience more social interaction with adults and peers. These interactions allow them to develop functions such as language skills, voluntary attention, scientific skills and memory. Vygotsky believed that the zone of proximal development of a child is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under guidance or in collaboration with more capable peers. The zone of Proximal Development is usually determined from below what a child can learn on his/her own, and above by what a child can learn with the help of others, such as peers or teacher as seen in Jig-saw(IV) Cooperative Learning Strategy. This study adopted the theory of constructivism, because students in J4CLS are active creator of their own understanding and knowledge of the concepts given through experiencing things and reflecting on those experiences. Also, in J4CLS introduction is the first step that provides an anchoring idea to understand the tasks given to them at hand.

The Jig-saw is a Cooperative Learning Strategy that is grounded in the belief that learning is most effective when students are actively involved in sharing ideas and work cooperatively to complete their academic task (Gumel, 2015). Jigsaw is a cooperative learning strategy in which everyone becomes an expert and shares learning so that eventually all group members understand the content treated. The Jigsaw model is chosen for the study because of its unique characteristic of providing optimum opportunities for the students to independently study the task given to individual member of the group. This model also makes students to become cream of the crop of their own learning.

The jigsaw technique was created with the goals of enhancing positive educational outcomes and to help students realize they are essential components of a whole and encourages cooperation in a learning environment (Aronson, 2008). In science education, the Jigsaw method is reported to be used in classes more often than other collaborative learning methods, especially in Mathematics, physical sciences and the Earth sciences (Ibrahim, 2019). This is because the Jigsaw method is considered to enhance cooperative

learning by making each student stress on a particular topic (Johnson, & Johnson, 2009). This study verified the effect of Jigsaw IV Cooperative Learning Strategy on Students' Retention in Zaria Metropolis Kaduna State, Nigeria.

Academic performance is the extent to which a student, teacher or institution has achieved their short or long-term educational goals (Tudunkaya & Jamilu, 2019). Completion of educational degrees such as higher diploma and bachelor's degrees represent academic achievement (Friedman & Mandela 2011). Academic performance is commonly measured through examinations and continuous assessments, but there is no general agreement on how it is best evaluated or which aspects are most important procedural knowledge such as skills or declarative knowledge such as facts. Furthermore, there are inconclusive results over which individual factors successfully predict academic performance, elements such as test anxiety, environment, motivation, and emotions require consideration when developing models of school achievement (Hannon & Ann 2014).

Retention however, refers to what is learned minus what has been forgotten (Mang & Mankilik, 2001). Retention as defined by Yero (2011) is the ability of a learner to recall, remember and recollect a body of Knowledge after passing through instruction. For students' retention, Omar (2012) observed that students' experience is a significant factor in retention and that the strategies of improving retention rate can be adopted by the teacher. Bichi (2002) opined that anything which aids meaningful learning improves students' retention and while things that lead to interference among learned materials decrease the speed and efficiency of learning and accelerates forgoing.

Idris (2014) observed that, retention is the ability to keep and consequently remember things or materials experienced or learned at a later time. Materials to be learned depend on the strategy used in teaching and have an effect to the quality of retention in terms of their meaningfulness, familiarity and image evoking characteristics (Bichi, 2002). Low academic performance as well as retention amongst students in Sciences seems to be as a result of use of teacher's-centered method which lead to poor academic retention, performance and acquisition of requisite skills (Usman, 2000). The Jigsaw model is one of the modern strategies that is students-centered and enhances meaningful learning through students' interaction in groups of 5-6 to construct their own knowledge, share ideas and complete a given task assigned to them (Gumel, 2010). Studies revealed that, lesson which applied the Jigsaw model was shown to be effective both in cognitive and affective characteristics including meaningful learning, retention; positive learning attitude, interest, self-respect, self-learning ability, confidence, task commitment, sociability, and so on (Yusuf, 2011).

## Objectives of the Study

The main objective of this study is to determine the "the Effect of Jigsaw IV Cooperative Learning Strategy on Students' performance and retention among Senior Secondary school students (SSII) of Zaria Metropolis, Kaduna State, Nigeria".

## Research Question

The study addressed these research questions.

1. Is there any significant difference in the mean performance scores of students in SSII taught 2-D geometry concept using J4CLS at Senior Secondary Schools two (SSII) of Zaria Metropolis, Kaduna State, Nigeria?
2. Is there any difference in the retention ability of students taught 2-D Geometry concept using J4CLS at Senior Secondary Schools two (SSII) of Zaria Metropolis, Kaduna State, Nigeria?

**Null Hypotheses**

Null hypotheses were formulated and tested at $P \leq 0.05$ level of significance:

$H0_{1:}$ There is no significant difference in the mean performance scores of SSII students taught 2-D Geometry concepts using J4CLS and those taught same concepts using the Conventional Method of Teaching in Zaria Metropolis, Kaduna State, Nigeria.

$H0_2$: There is no significant difference in the retention ability of SSII students taught 2-D Geometry concepts using J4CLS and those taught same concepts using the Conventional Method of Teaching in Zaria Metropolis, Kaduna State, Nigeria.

**Research Design**

The design for this study is pretest, posttest, and post posttest quasi-experimental research design. This is according to Kerlinger and Leer (2005) involves two groups, one group was assigned as experimental and the other group was tagged control. This is suitable because of the advantages listed by (Lakpini, 2006 in Ibrahim, 2019) which is as follows;

1. The superiority of one instructional strategy over the other can easily be tested
2. It gives indications of concept attainment ability of understanding gained by students after they have been exposed to a particular teaching treatment.
3. The pretest scores give indication as to whether the groups are equal in the concepts they hold before interaction was given.
4. The population of this study comprises of fifteen (15) public Senior Secondary Schools (SS II) Students in Zaria Metropolis two (2) schools were randomly selected as sample for the study.

The samples selected were pre-tested to ensure that they are not significantly different. The experimental group was exposed to Geometry concepts for five weeks using J4CLS while the control group was exposed to Geometry concepts also for five weeks using lecture method. A post test was administered to observe if there was any significant difference in students' academic performance among the groups. A post-posttest was administered to both experimental and control group to observe if there was any significant difference in students' retention ability in Geometry concepts.

The instrument for this study is Geometry Performance Test (GPT) was developed for the purpose of generating and analyzing data. The GPT comprises ten (10) items of essay test questions, this is because: Essay test allow students to express their ideas with relatively few restraints. Essay involves recall and write thereby no options to select from, therefore guessing is eliminated. The students must supply answer rather than selecting the good response, thus, it involve descriptive knowledge of students. The posttest in this study is to check the academic performance of the students in SSII on Geometry Concept in Zaria local government. The data collected was used to find the reliability coefficient of the

instruments. For the purpose of this study, a test was conducted in order to obtain the data from the preferred School that was pilot tested. The reliability coefficient, was found to be 0.79 using SPSS. Pre-test was administered to both sampled population groups and the records was kept, then the control group was treated using lecture method of teaching while the experimental group was treated with the Jigsaw IV Cooperative Learning Strategy for five weeks. Then, post-test was administered to both the control and the experimental groups. Later, after sometimes post-post-test was administered to the experimental group so as to ascertain the retention ability of the groups. The data collected were analyzed by the application of both descriptive and inferential Statistics. For descriptive Statistics mean and standard deviation was used to describe the research questions while for inferential Statistics t-test was used to answer the null hypotheses at $\alpha=0.05$ (5%) level of significance.

**Result**

Research Question 1:Is there any significant difference in the mean performance scores of students in SSII taught 2-D geometry concept using J4CLS at Senior Secondary Schools two (SSII) of Zaria Metropolis, Kaduna State, Nigeria?

**Table 1: Descriptive Statistics on Performance**

| Group | N | Min. | Max. | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Experimental | 85 | 15 | 39 | 30.31 | 7.83 |
| Control | 72 | 2 | 23 | 14.90 | 6.57 |

The results in Table 1 above showed that the students in the experimental group had a mean score of 30.31 performed higher than their counterparts in the control group with a mean score of 14.90 with the mean difference of 15.41.

$H0_1$: There is no significant difference in the mean performance scores of SSII students taught 2-D Geometry concepts using J4CLS and those taught same concepts using the Conventional Method.

**Table 2: Inferential Statistics for Performance**

| Group | N | Mean | SD | $t_{cal}$ | $t_{crit}$ | Df | Remark |
|---|---|---|---|---|---|---|---|
| Experimental | 85 | 30.31 | 7.83 | 10.95 | 1.98 | 155 | S |
| Control | 72 | 14.90 | 6.57 | | | | |

Table 2 showed that the mean scores of both the experimental and control groups with the mean of 30.31 and 14.90 respectively. The mean difference between them is 15.41.

Thehypothesis one ($H0_1$) says: "there is no significant difference in the mean performance scores of SSII students taught 2-D Geometry concepts using J4CLS and those taught same concepts using the Conventional Method". But from the table two (2) above we have $t_{critical\ (10.95)} > t_{calculated\ (1.98)}$ at $\alpha=0.05$ level of significance. Hence, $H0_1$ is rejected.

Research question 3: Is there any difference in retention ability on students taught 2-D Geometrywith J4CLS and lecture Method of Teaching?

**Table 3: Descriptive Statistics on Retention Ability**

| Group | N | Min. | Max. | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Experimental | 85 | 12 | 29 | 28.10 | 7.70 |
| Control | 72 | 4 | 17 | 13.31 | 4.74 |

The results in Table 2 above shows that the students in the experimental group had a mean score of 28.10 retained higher than their counterparts in the control group with a mean score of 13.31 with the difference of 14.79.

$Ho_2$: There is no significant difference between in the retention ability of Students taught 2-D Geometryconcept with J4CLS and those taught with lecture method.

**Table 4: Inferential Statistics for Retention**

| Group | N | Mean | SD | $t_{cal}$ | $t_{crit}$ | Df | Remark |
|---|---|---|---|---|---|---|---|
| Experimental | 85 | 28.10 | 7.70 | | | | |
| | | | | 15.78 | 1.65 | 155 | S |
| Control | 72 | 13.31 | 4.74 | | | | |

Table 4 showed that the mean scores of post posttest of both the experimental and control groups with the mean of 28.10 and 13.31 respectively. The mean difference between them is 14.79. The hypothesis one says "there is no significant difference in the retention ability of students taught 2-D Geometry concept with J4CLS and that of those taught using conventional method". But from the table above we have $t_{critical\ (15.78)} > t_{calculated\ (1.65)}$ at $\alpha$=0.05 level of significance. Thus, $H0_1$ is rejected.

**Results**

Results of testing null hypotheses showed that significant difference exist in the mean performance scores and retention ability of SS II Students taught with J4CLS and those taught with lecture method. The result of the mean scores of the student in the experimental group maintained a higher performance and retention rates than their counterparts in the control group.

The nature of J4CLS is learning by doing and elaborating. In J4CLS, the students worked together in groups, where each student became an 'expert' for a specific topic, and subsequently taught this topic to his or her home group. This finding agrees with the findings of Sousa (2006), Tanel & Erol (2008), who found that students in the experimental group taught science concepts with Jigsaw cooperative learning settings had higher retention than those in control group, taught science concepts using traditional method.

Specifically, the finding of Sousa (2006) reports the average percentage of learning material retention after 24 hours when students were taught by different teaching methods. He indicated that there was retention of 50% of material learned in the discussion group, 75% as a result of requests for students to study through practice, and 90% when students teach others in a jigsaw cooperative learning strategy.

An impressive study which lasted for 4 weeks was conducted by Tanel and Erol (2008) in which the effectiveness of the Jigsaw learning method and conventional teaching method

were compared on achievement and retention in a Physics course in a University in Turkey. An experimental group received the Jigsaw technique and a control group received traditional lecture teaching.

## Conclusion

As a result of the findings in this study, it could be concluded that J4CLS enhances performance and retention of 2-D Geometry concepts of secondary school students. This is because all SS II students exposed J4CLS, performed and retained 2-D Geometry concepts better than those exposed to traditional method of teaching. J4CLS. In addition, students become active author of their knowledge, analyzed such knowledge and apply it to a real life situation as in J4CLS.

## Recommendations

On the basis of the findings and conclusion arising from this study, the following recommendations were made;

The use of Jigsaw IV Cooperative Learning Strategy, J4CLS seems to be appropriate in improving the performance and retention ability of students in senior secondary schools 2-D Geometry. It should therefore, be incorporated into the main stream of pedagogy in the teaching of Mathematics specifically 2-D Geometry and other science subjects at senior secondary schools in Zaria Metropolis, Kaduna State, Nigeria.

The use of Conventional Method of Teaching, it has been found in this study, to be relatively ineffective, with respect to performance and retention in the learning of 2-D Geometry concepts. Mathematics teachers should therefore, exercise cautiousness and expertise in enriching the Conventional Method of Teaching with innovative strategy such as J4CLS so as to avoid situation where under achievement is unwittingly promoted in the course of teaching.

## Reference

Aronson, E. (2008). *History of Jigsaw*. Retrieved from*https://www.jigsaw.org/history.htm*

Bichi, S. S. (2002). Effects of Problem Solving Strategy and Enriched Curriculum on Students Achievement in Evolution Concepts among Secondary School Students. An Unpublished Ph.D. Dissertation, Faculty of Education, ABU Zaria.

Friedman, B. A. & Mandel, R. G. (2011). Motivation predictors of college student's performance and retention Journal of College Student Retention: *Research, Theory & Practice*. **13** (1): 1–15.

Gerald, I. O. (2012). Mathematics: A tool for addressing the challenges for security and poverty reduction in Nigeria. A paper presented at the National Conference organized by Nigerian Mathematical Society held at Ahmadu Bello University Zaria.

Gumel, S. A. (2015). Effects of jigsaw model of cooperative learning on self-efficacy and achievement in chemistry among concrete and formal reasoning in colleges of Education in Nigeria. Department of Science Education, Ahmadu Bello University, Zaria, 34-40.

Hannon, B. & Ann, M. (2014). "Predicting College Success: The Relative Contributions of Five Social/Personality Factors, Five Cognitive/Learning Factors. *Journal of Education and Training Studies,* **2** (4): 46–58.

Hassan, A.A (2007). Critical factors affecting the mathematics teacher in the 21st Century: Possible way forward. *A journal of educational research and development faculty of education Ahmadu Bello University Zaria,* **2** (1).

Idris, Y. (2014). Impact of problem solving strategy in academic achievement and retention on basic science concept among varied ability students, Kaduna State Nigeria. Unpublished M.ed Thesis, Department of Science Education, Ahmadu Bello University, Zaria. 3-44.

Johnson, D. W. & Johnson, R. T. (2009). An educational psychology success story: social interdependence theory and cooperative learning. *Educational Researcher*, **38** (5): 365-379.

Kerlinger, F. N. and Leer, H. Z., (2005). Foundation of Behavioral Research. Fourth Edition, New York: Harcourt Higher Learning Company.

Krejcie, R., Morgan, R.W., (1970). Determination of sample size for research approach. *Educational Psychology Measurement,* **30**: 607-610

Lakpini, M. A. (2006). Effect of a Conceptual Change Instructional Strategy on the Achievement, Retention and Attitude of Secondary School Biology Students with Varied Ability. Unpublished PhD Dissertation, Ahmadu Bello University, Zaria.

Okpala, J. U. and Asiegbu, F. N. (2016). Role of mathematics skills in the development of Human Capacity building in the private sector for national development. Mathematical Association of Nigeria, Annual National Conference Proceeding, held at Ahmadu Bello University Zaria, Kaduna State.

Piaget, J. (1967). *The Child's conception of the world*, Routledge and Kegan Paul Limited.

Pereira, J., Wijaya, T. T., Zhou, Y. & Purnama, A. (2021). Learning points, lines, and plane geometry with Hawgent dynamic mathematics software. *Journal of Physics: Conference Series* **1882** (2021) 012-057 IOP Publishing doi:10.1088/1742-6596/1882/1/012057

Sousa, D. A. (2006). How the brain learns (3). Heatherton, Vic: Hawker Brownlow Education.

Tanel, Z. & Erol, M. (2008). Effects of Cooperative Learning on Instructing Magnetism: Analysis of an Experimental Teaching Sequence. *American Journal of Physics and Education,* **2** (2): 124-136.

Tudunkaya M. S. & Jamilu, A. A. (2019). Impact of Problem-Solving Strategy on performance in 3-D Geometry among SSII in Zaria Educational Zone Kaduna State Nigeria. *A journal of Mathematical Association of Nigeria (M.A.N) Abacus2019.*

Usman, I. A. (2010). The Effects of Indoor and Outdoor Laboratory Instructional Method on Academic Performance of Junior Secondary School Students in Zaria Local Government Area of Kaduna State. *Journal of Studies in Science and Mathematics Education*, **1** (1): 66-73

Vygotsky, L. (1978). Interaction between learning and development. In Gauvain & Cole (Eds.), *Readings on the development of children* (pp. 34-40). New York: Scientific AmericanBook.

Yero, H. I. (2011). Effects of computer animation model on students' performance and retention in organic chemistry concepts among colleges of education in Plateau State. Unpublished M.ed Research Thesis. Ahmadu Bello University Zaria.

Yusuf, M. O. (2011). Perspective on the integration of information and communication Technology in Nigerian School System. *Journal of Science, Technology and Mathematics Education.* **7** (2): 229-239. *www.stlouisfed.org.2014/preservaticles.com*12/12/2016.