# EFFECT OF JIGSAW-BASED COOPERATIVE LEARNING STRATEGY (JBCLS) ON SENIOR SECONDARY SCHOOL STUDENTS'INTEREST AND ACHIEVEMENT IN PHYSICS

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**Abstract**

*The study determined the effect of jigsaw-based cooperative learning strategy (JBCLS) on senior secondary school students' interest and achievement in physics. Two research questions were posed and two hypotheses formulated for the study. A non equivalent control group quasi-experimental research design was adopted for the study. The study was carried out in Agbani Education Zone of Enugu State. A sample size of three hundred and sixteen (316) SS1 physics students from four schools was used for the study. The students in two different groups of the intact classes were taught using jigsaw based cooperative strategy (JBCLS) and lecture method respectively. Physics achievement test (PAT) and Physics interest inventory (PII) were used to collect data. The instruments were trial tested and a reliability index of 0.79 and 0.81 were obtained for the instruments respectively. The research questions were answered using mean and standard deviation and hypotheses tested using analysis of covariance (ANCOVA). The findings revealed that use of jigsaw based cooperative learning strategy was more superior in enhancing interest and achievement of physics students than lecture method. Thus, the study recommended adequate training of physics teachers on the effective use of jigsaw based cooperative learning strategy for innovative teaching. Also, that physics curriculum planners should include the use of jigsaw based cooperative learning strategy to aid innovative education.*

**Keywords:** *Jigsaw-Based, Cooperative Learning Strategy, Physics, Interest, Achievement, Innovative Education.*

## Introduction

The frontiers of modern physics have given rise to different methods of exploration leading to in-depth examination and discoveries of the 21th century. The discoveries made from the study of physics find their application throughout the natural sciences, since matter and energy are the basic constituent of the natural world (Ugwuanyi, Nwankwo & Ugwuoke, 2016). This implies that the study of energy, matter and its interaction are better done with physics. The study of physics involves

a systematic method which is referred to as scientific procedures. However, scientific procedures undertaken to make a study, test a theory or demonstrate a known fact could lead to big questions (Tompkins, 2017). Such questions could be; what is the universe made of? What are the most fundamental particles and how do they interact with each other? What can we learn about the history of the universe and what does it tell us about its future? The above stated questions to some extent could stir up students' interest to know and also give an answer to such questions. This means that questions bring student into action so as to give the required answer. To this end, the student academic interest is stirred up. Hence, studies on students' academic interest in physics are important so as to show the level of concern students possess in tackling questions or tasks so as to increase their knowledge base.

Interest is referred to as the state of involving or been made available with particular classes of objects, events or ideas over time (Hidi & Renninger, 2006). This implies preference, affinity or special likeness towards an event, set of activities or object. However, in teaching and learning students' academic interest should not be neglected since the failure of students to achieve or do well in the test, could be attributed to lack of interest (Ezea, 2014). This is because students' academic interest has a strong positive relationship with performance (Azmin, 2015). Students' academic interest refers to the feeling of curiosity or concern among students about learning any task that draws all their attention (Ugwuanyi, Nwankwo & Ugwuoke, 2016). For instance, a student who decides to learn the concept of energy pays attention and also devotes time to it. Thus, to that student, the concept is very enjoyable to undertake because he or she derives some pleasure in doing it. In a similar view, Harbor-Peters (2002) sees students' academic interest as the zeal or willingness of the student to participate in any academic activity from which the student derives some pleasure. However, several research studies on students' academic interest in science education have shown that academic interest is a predictor of students' enrolment, perception and achievement in some STM subjects (Ogbonna, 2015); academic interest predicts students' performance in their different ability levels (Hayden, Benbow, Geary, Gur, Hyde & Gernsbacher, 2011); students academic interest in trigonometry arouse there problem solving strategies in mathematics (Harbor-Peters, 2001; Nekang, 2013). None of the above stated studies investigated on the utilization of jigsaw-based cooperative learning strategy on physics students' academic interest and achievement among senior secondary school. The present study sets to fill such gap.

It is interesting to note that interest engenders students' academic achievement (Ezea, 2014). Students' academic achievement could be conceived as the range to which a learner has fulfilled the stipulated objectives of a particular course (Ikeh, Ugwuanyi & Orji, 2016). In this context, it implies that the student has acquired knowledge through teaching process. Similarly, Bamiro (2015) sees students' academic achievement as an elicited response, showing performance in which a

learner is assigned a score representing his or her ability. The above definition means that academic ability is fundamental to students' academic achievement. Therefore, the success or otherwise of any student involved in educational endeavor is determined through the students' academic achievement (Ekweoba, 2014). Students' academic achievement can be accessed through achievement tests or examination and observation (Ernest-Ehibudu & Opurum, 2013). Achievement test may be teacher-made test or standardized test (Nworgu, 2015). However, students' academic achievement test results from standardized test body like WAEC Chief Examiners report (2015, 2016 & 2017) showed poor students' academic achievement specifically in physics. To this effect, different researchers have adduced various factors for poor academic achievement of students in physics. Such factors include gender and socio-economic status (Ewumi, 2009); project-based, demonstration and lecture teaching strategy (Olatoye & Adekoye, 2010); teaching methods and students' academic achievement (Emaikwu, 2012; Idris & Rajuddin, 2012); teaching methods, cooperative learning strategies and gender (Jensen & Owen, 2013). Thus, there is the need to investigate on physics students' academic interest and achievement using cooperative learning strategy as a teaching method.

Cooperative learning strategies are organized and structured methods used on small groups to enhance students' learning and interdependence (Azim, 2015). This implies that when students are given task (or assignment) in small groups, each individual in the group has the obligation of aiding in the completion of such assignment. Hence, excellent performance is dependent on the contribution of everyone in that small group. However, Nkadi (2017) pointed out that 2 to 6 per group (with respect to gender and ability level) should constitute each small heterogeneous group on task assigned by the teacher. The formation of such group helps in increasing positive attitude towards subject areas and classmate; increased comprehension, retention and recall. Azmin (2015) outlined different types of cooperative learning strategies as; Team-Game-Tournaments (TGT), Students Team Achievement Divisions (STAD), Team Acceleration Instruction (TAI), Pair Check, Think-Pair-Share (TPS), Cooperative Integrated Reading and Competition, Learning Together Model, Jigsaw Based Cooperative Learning Strategy (JBCLS). In this study, the researchers considered JBCLS among other cooperative learning strategies since it makes use of lesson content that is subdivided into various topics. The subdivision of lesson contents could be geared towards aiding students to achieve better in physics.

JBCLS as a variable under investigation in the present study is attributed to be well planned and structured procedures with suitable instructional materials and specific guidelines for all participants that make students dependent on each other for meaningful learning (Nkadi, 2017). JBCL as an instructional procedure was originally developed by Aronson in 1971 and first experimented by Blaney, Stephan, Rosenfield, Aronson, and Sikes in 1977 (Wikipedia Contributors, 2019). This instructional procedure makes use of lesson content which is subdivided into different

parts of assignment or topics called jigsaw puzzle (Williams, 2008). However, jigsaw puzzle is further divided into smaller segments termed jigsaw puzzle piece. Williams also narrated the application of jigsaw based cooperative learning approach which involves; assigning students the jigsaw puzzle piece (i.e. subtopics) by breaking them into home groups. Each member of the home group is given a different subtopic and must study his/her jigsaw puzzle piece in order to form the complete puzzle. JBCLS is useful where new learning material or information is to be effectively learned by the students (Nkadi, 2017). The teacher may wish to design expert sheet that presents questions to obtain information needed from the students.

Despite the well structured nature of jigsaw based learning strategy, different research findings have shown that jigsaw based learning strategy is not interested on high achieving/intelligent students, since the method mostly does not engage the students in performing difficult task. Some of these previous research includes; effect of jigsaw cooperative learning on students academic achievement (Sahin, 2010); jigsaw-based cooperative learning approach to improve students' learning outcomes (Huang, Liao, Huang & Chen, 2014); efficacy of jigsaw method on students self esteem and social/relationship skills (Johnson & Johnson, 2009). However, most of these studies did not reveal if students taught using jigsaw cooperative learning method have better academic interest and achievement than those taught using lecture method. Hence, the reason for the study, utilizing jigsaw-based cooperative learning strategy among senior secondary school students in physics for better academic interest and achievement.

**Research Questions**

In this study, answers were provided to the following questions;

1. What are the mean interest ratings of senior secondary school physics students taught using JBCLS and those taught with lecture method?
2. What are the mean achievement scores of senior secondary school physics students taught using JBCLS and those taught with lecture method?

**Research Hypotheses**

The following null hypotheses guided the study. All the hypotheses were tested at 0.05 level of significance.

**$HO_1$**: There is no significant difference in the mean ratings of senior secondary school physics students' academic interest when taught using JBCLS and those taught with lecture method.

**$HO_2$**: There is no significant different in the mean achievement scores of senior secondary school physics students taught using JBCLS and those taught with lecture method.

**Research Method**

The study adopted quasi experimental research design. Specifically, non equivalent control group research design. The population of the study comprised of all the SS1 students in Nkanu-West LGA of Enugu State. A sample size of 316 SS1 physics students from two schools was used for the study. Simple random sampling technique specifically with replacement was used to determine the sample size. Four intact classes were used. Each intact class contains 79 students making the sample size to be 316. Physics Achievement Test (PAT) and Physics Interest Inventory (PII) were used for data collection from the respondents. The PAT was compiled by the researchers and it is made up of 25 multiple choice questions with a, b, c, d, e, alternatives (options). The PAT was used to determine SS1 students' achievement both before and after the instructional treatment (pretest and posttest). The 25 questions were selected by the researchers based on SS1 physics content (i.e. work, energy and power) that can be effectively taught using Jigsaw cooperative learning strategy. Test blue print or table of specification was used to ensure content coverage. PII was also developed by the researchers and it consists of 20 items that were used for data collection. PII is a 4 points scale instrument of strongly agree (SA) 4 points; Agree (A) 3 points; Disagreed (D) 2 points; and Strongly Disagreed (SD) 1 point. IIP scoring ranges from 4-1 for (SA-SD) which represents positively cued interest statement while the negatively cued interest statement ranges from 1-4 for (SA – SD).

The two instruments (PAT & PII) were validated by three experts all from Science Education Department, University of Nigeria, Nsukka. Trial testing was done using twenty (20) physics students from school outside the sample of the study which have similarities that are necessary for the study. An estimate of internal consistency known as Kuder-Richardson 20 (KR-20) formula was used to estimate the reliability of the PAT after trial testing. The choice of this reliability estimate was because PAT was dichotomously scored. With this formula, the internal consistency index of the items of the instrument was 0.79. The reliability of PII was estimated using Cronbach alpha formula which gave an index of 0.81. The choice of reliability estimate was because PII was non-dichotomously scored (polychotomous).

PAT and PII were used to collect data from four intact classes which were meant to cover the same learning contents (i.e. work, energy and power). Two lesson plans were produced for the JBCLS (i.e. experimental group) while two lesson plans on the same topic were produced for lecture method (control group). The treatment lasted for four weeks. The sampled students' teachers were used as research assistants. The reason for the choice of student teachers as research assistants was to mitigate faking of response by the students. This is because new teacher other than their own teacher may bring the students thought of been used for experiment. The research assistants were properly trained using JBCLS lesson plans and lecture method lesson plans. After the experiment for four weeks, the control group taught

the same learning unit for four weeks using without JBCLS lesson Plan. Posttest was administered to both the experimental and control groups of the intact classes. The scores of the experimental group in both pretest and posttest was recorded and compared with the scores gotten by the control group. The data collected were analyzed using mean and standard deviation to answer the research questions, while analysis of covariate was used to test the null hypotheses at 0.05 level of significant.

**Results**

**Research Question 1:** What are the mean interest ratings of senior secondary school physics students taught using JBCLS and those taught with lecture method?

**Table 1: Mean and standard deviation of interest ratings of students before and after treatment**

| Methods | N | Pre-test Mean | Std.dev | Post-test Mean | Std.dev | Mean Gain |
|---|---|---|---|---|---|---|
| Jigsaw-Based cooperative learning strategy (JBCLS) | 156 | 19.67 | 2.00 | 22.31 | 1.69 | 2.64 |
| Lecture Method | 160 | 16.60 | 2.08 | 18.71 | 2.03 | 2.11 |

From the Table 1, the mean interest rating of students taught physics using jigsaw based cooperative learning strategy (JBCLS) is 22.31 with standard deviation of 1.69 after the treatment as against their mean interest ratings of 19.67 with standard deviation of 2.00 before the treatment. Also the students who were taught physics with lecture method had mean interest rating of 18.71 and standard deviation2.03 after the treatment as against their mean interest ratings of 16.60 with standard deviation of 2.08 before the treatment. Mean interest gain ratings of 2.64 and 2.11 for the two groups respectively indicates that the students who were taught using jigsaw based cooperative learning strategy had higher mean interest ratings than those taught with lecture method.

**Hypothesis 1:** There is no significant difference in the mean rating of senior secondary school physics students' academic interest when taught using JBCLS and those taught without using JBCLS.

**Table 2: ANCOVA of effect of jigsaw-based cooperative learning strategy on academic interest mean ratings in physics**

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 1372.371[a] | 2 | 686.186 | 285.379 | .000 | .646 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Intercept | 486.977 | 1 | 486.977 | 202.529 | .000 | .393 |
| Pretest | 347.784 | 1 | 347.784 | 144.640 | .000 | .316 |
| Group | 204.048 | 1 | 204.048 | 84.862 | .000 | .213 |
| Error | 752.600 | 313 | 2.404 | | | |
| Total | 134801.000 | 316 | | | | |
| Corrected Total | 2124.972 | 315 | | | | |

a. R Squared = .646 (Adjusted R Squared = .644)

Table 2 shows that the calculated value of F (84.862) for the effect of jigsaw based cooperative learning strategy on academic interest among senior secondary school physics had an associated probability value of 0.000. Since the probability value of 0.000 is less than the 0.05 level of significance, the null hypothesis was rejected. This implies that there is a significant difference in the mean ratings of senior secondary school physics students' academic interest when taught using JBCLS and those taught with lecture method.

**Research Question 2:** What is the mean achievement scores of senior secondary school physics students taught using JBCLS and those taught without using JBCLS?

**Table 3: Mean and standard deviation of achievements cores of students before and after treatment**

| Methods | N | Pre-test Mean | Std.dev | Post-test Mean | Std.dev | Mean Gain |
|---|---|---|---|---|---|---|
| Jigsaw-Based Cooperative Learning Strategy (JBCLS) | 156 | 12.92 | 1.69 | 15.90 | 1.92 | 2.98 |
| Lecture Method | 160 | 9.74 | 1.65 | 12.17 | 2.02 | 2.43 |

Table 3 shows that the mean achievement scores of students taught physics using jigsaw based cooperative learning strategy (JBCLS) is 15.90 with standard deviation of 1.92 after the treatment as against their mean achievement scores of 12.92 with standard deviation of 1.69 before the treatment. Also the students who were taught physics with lecture method had mean interest rating of 12.17 and standard deviation2.02 after the treatment as against their mean interest ratings of 9.74 with standard deviation of 1.65 before the treatment. Mean achievement gain ratings of 2.98 and 2.43 for the two groups respectively indicates that the students who were taught using jigsaw based cooperative learning strategy had higher mean achievement rating than their counterparts.

**Hypotheses 2:** There is no significant different in the mean achievement scores of senior secondary school physics students taught using JBCLS and those taught with lecture method.

**Table 4: Analysis of Covariance (ANCOVA) of the effect of JBCLS on students' achievement mean scores in physics**

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 1215.423[a] | 2 | 607.712 | 171.283 | .000 | .523 |
| Intercept | 660.353 | 1 | 660.353 | 186.119 | .000 | .373 |
| Pretest | 113.475 | 1 | 113.475 | 31.983 | .000 | .093 |
| Group | 275.811 | 1 | 275.811 | 77.737 | .000 | .199 |
| Error | 1110.526 | 313 | 3.548 | | | |
| Total | 64374.000 | 316 | | | | |
| Corrected Total | 2325.949 | 315 | | | | |

a. R Squared = .523 (Adjusted R Squared = .519)

**Table 4** indicates that the calculated value of F (77.737) for the effect of jigsaw based cooperative learning strategy on academic achievement among senior secondary school physics had an associated probability value of 0.000. Since the probability value of 0.000 is less than the 0.05 level of significance, the researcher fails to accept the null hypothesis. This implies that there is significant difference in the mean rating of senior secondary school physics students' academic achievement when taught using JBCLS and those taught with lecture method.

**Discussion of Findings**

The findings of the study revealed that students who were taught using JBCLS had higher mean interest ratings than those taught with lecture method. Further analysis showed that there is significant difference in the mean rating of senior secondary school physics students' academic interest when taught using JBCLS and those taught with lecture method. The findings of the study have confirmed that JBCLS triggers and sustained students' academic interest in physics. The findings of this study also corroborate those of the previous works by Ugwuanyi, Nwankwo and Ugwuoke (2016), and Subramaniam (2012) that the active participation of students in learning context improves their interest. Ugwuanyi, Nwankwo and Ugwuoke (2016) revealed that students' active participation during lessons may spur their interest into the business of learning thereby having more interest than those who were not actively engaged in the lesson. Timayi, J.M. (2013) observed thatjigsaw IV cooperative learning strategy improved students' interest in geometry better than the lecture method. Thus, the implication of this study has it that, exposure of physics concepts

to students using jigsaw cooperative learning strategy increases their academic interest.

Also the findings showed that students who were taught using jigsaw based cooperative learning strategy had higher mean achievement scores than their counterparts. It was further confirmed that there is significant difference in the mean scores of senior secondary school physics students' academic achievement when taught using JBCLS and those taught with lecture method. This finding concurs with the previous works by Kilic (2010), Azmin (2015), Yemi, T.M., Hj Azid, N.B. and Md Ali, M.R. (2018). Kilic (2010) reported that there is significant difference in students' academic achievement when taught with jigsaw method. Azmin (2015) revealed that jigsaw cooperative learning has improved students academic achievement and could possibly lead to better learning outcome. Also, Yemi, T.M., Hj Azid, N.B. and Md Ali, M.R. (2018) found that jigsaw strategy was more effective than the traditional teaching method in increasing students' academic achievement in mathematics. This finding implies that the use of jigsaw based cooperative learning strategy in physics develops students' discussion and confidence skills on the process helping students to establish friendship and network.

**Conclusion**

In a nutshell, the findings of the present study showed that the use of JBCLS was superior in enhancing academic interest and achievement of physics students than with lecture method. Thus, students taught physics using jigsaw based cooperative learning strategy achieved better than their counterparts.

**Implication of the Findings for Innovative Education**

Ineffective use of teaching methods by teachers in teaching physics concepts has made the subject extremely difficult on improving the students' interest and achievement. No doubt, we still witness students' poor interest and achievement in our education system since most school physics teachers are not acquainted with teaching methods that are innovative. However, innovative education which engages students on critical thinking enhances their interest and achievement. Interestingly, the study found out that students taught using jigsaw based cooperative learning strategy have higher mean interest and achievement rating more than those taught without using jigsaw cooperative strategy. The implication of the finding is that a country that wants to develop her citizen to compete globally in science and technology, should adopt and train her science teachers (specifically physics) on the use of JBCLS. This will harness the learners interest and achievement.

**Recommendations**

From the above conclusion, the researchers recommended; thus:

1. The ministry of education should collaborate with state government and school management to ensure that senior secondary teachers are adequately trained on the effective use of jigsaw based cooperative learning strategy.
2. In the view of the fact that jigsaw cooperative learning strategy improves students' confidence and social skills, it is recommended that the curriculum planners should revisit the physics curriculum in order to include the use of jigsaw based cooperative learning strategy.

**Acknowledgements**

The researchers sincerely acknowledged the cooperation of the principals, vice principals, Physics teachers and students of the selected schools that participated in the study.

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