EFFECTS OF JIGSAW II COOPERATIVE LEARNING STRATEGY ON SENIOR SCHOOL STUDENTS' PERFORMANCE IN PHYSICS IN LAFIAGI, KWARA STATE, NIGERIA

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Abstract

The study investigated the effects of Jigsaw II cooperative learning strategy on senior school students' performance in physics. The study also determined how moderating variables of score levels influence students' performance in physics when jigsaw II cooperative learning strategy was used as instructional strategy. The study employed a quasi-experimental design of non-randomized, non-equivalent pre-test post-test control group design. Random sampling technique was used to select two senior secondary school III (SSSIII) physics students comprising 146 (68 male and 78 female) from two intact classes in Lafiagi, Kwara State, Nigeria. Jigsaw II Cooperative Learning Instructional Package on Electric Field (JIICLIPEF) and Electric Field Performance Test (EFPT) were used as treatment and test instruments. Data were collected and analyzed with t-test and Analysis of Covariance (ANCOVA) statistical tools Findings indicated that students taught electric field (current electricity) using jigsaw II cooperative learning strategy performed better than those taught with conventional methods, and there was no significant difference in the performance of students taught electric field with Jigsaw II on the basis of score level. It was therefore recommended based on the findings that teachers should make use of Jigsaw II cooperative learning strategy in order to enhance students' performance in the electric field.

Keywords: *Cooperative learning, Electric field, Jigsaw II, Performance, Physics.*

Introduction

Science plays important and dominant roles in spearheading technological advancement, promoting national wealth, improving health, and accelerating industrialization (Validya, 2003; Yuan et al., 2020). Electricity and electronics developed from the knowledge of physics is used for the development of telephones, optics cable, and also the internet that brings all parts of the

world together (Johnson, 2015;Sani, 2012).This statement points to the fact that for Nigeria to develop scientifically and technologically, the teaching and learning of physics should be encouraged.

Physics is a branch of science that deals with energy and matter, and their interactions (Tassie, 1973; Bello and Akinfesola, 2015; Coccia, 2020). It is one of the most fundamental scientific disciplines and its main goal is to understand how the universe behaves, so physics is the backbone of technology (Beveridge, 2017; Yusuf, 2020). The relevance of physics education in sustaining the country's technological development makes it imperative to proffer urgent solution to myriad of problems befalling it in terms of teaching qualities and learning the right concepts (Jegede & Adedayo, 2013).It is also a science subject that students often find very difficult and as a result failed(Assouline, et al., 2006;Yusuf, 2020).Despite the importance of physics as a requirement for science and engineering courses at the tertiary educational institutions, students' performance at the Senior School Certificate Examinations (SSCE) in Nigeria has been fluctuating over the years. The West African Examinations Council (WAEC) Chief Examiners' Reports (2010, 2011, 2012, 2013 & 2015) showed that electric field (current electricity) is one aspect of physics that students find difficult. According to the (WAEC) (2010-2015) Chief Examiners' Reports, it was observed that students avoid questions on current electricity while the few students that attempted questions on current electricity performed poorly.

The reason for the inconsistent performance in physics examination can be attributed to the abstract nature of the subject (Adeyemo, 2010). Ukoh (2010) opined that the reasons responsible for inconsistent performance of students in physics include inefficient teaching methods adopted by physics teachers in the field, poor manipulation of science process skills, learners' variables such as gender stereotype in physics and lack of confidence by physics students in their approach to tackling physics problems. Adebisi et al. (2020) investigated the difficulty levels of senior school physics concepts as perceived by students and teachers in Ilorin, where recommendation were made to raise levels of students' perception of difficulty levels of physics concept. Cañada et al. (2011) stated that current electricity is one of the topics students find difficult and abstract. This is because it has been recognized as a concept that students found difficult to learn and understand. Erinosho (2013) also revealed that students generally regard physics as conceptually difficult, abstract, uninteresting, and an elite discipline only suitable for exceptionally talented and gifted students compared with other science subjects.

Agummuoh and Ifeanacho (2013) stated that poor performance of students in physics particularly on questions related to the electric field can be attributed to many factors among which is teachers' teaching method such as the conventional method amongst others. Anyafulude (2014) revealed that by this method (conventional method) learners are encouraged to master course content through constant repetition of facts and drills. Though this method guarantees the completion of tasks on time, it encourages learners to memorize and regurgitate content of learning experiences instead of digesting and assimilating them. Hence, this method does not allow students to be actively involved in the learning process, thus making them lose interest in the subject which leads to poor performance in the subject. In the light of the problems stated earlier, the researcher adopted an active pedagogical strategy for this study, which is the jigsaw II cooperative learning strategy to find out if students' performance in

physics could be improved upon. Agommuoh and Ifeanacho (2013) asserted that physics could be well understood if students are taught with effective teaching strategies. Afterwards, Steedly (2009) is of the view that one needs to ask two questions before selecting the appropriate instructional strategy for a particular concept: What do students need to know mathematically? and What instructional approaches or strategy are effective in teaching those skills? One of the strategies is Jigsaw Cooperative Learning Strategy.

Jigsaw is one of the cooperative learning strategies which are based on group dynamics and social interactions. This technique, including two different treatments administered on different small groups in order to help learning and improve cooperation between students, was first designed by Aronson in 1978 (Hedeen, 2003). In the application of Jigsaw technique, students separate from their initial groups (home groups) and form new groups (expert groups) with the other students who are responsible for preparing the same subjects. The home group is the initial group where students have different materials they are to study and then break apart, like pieces of a jigsaw puzzle, where students who have been assigned the same portion of the material move into an expert group. While in the expert groups, the students discuss their particular material to ensure that they understand it. Students then return to their home groups, where they teach their material to the rest of their group (Colossi & Zales, 1998). In jigsaw groups, the students may take charge more than once in order to instruct the lesson (Grasha & Yanberger-Hicks, 2000). In jigsaw technique, the students are participants of two different groups: home group and expert group.

Jigsaw technique allows students to actively participate in the learning process. By being constantly subjected to this method, they feel more comfortable about their roles. Ways of evaluating the groups can enhance the effectiveness of the jigsaw technique by making each student have a sense of responsibility for their group's performances (Lucas, 2000). In jigsaw technique, each student prepares a part of the assignment outside the classroom. Later they return to their groups and peer-teach other members. Whereas all groups can take the same subject, different groups can take different parts of it as well. Groups are reorganized to teach the subject in turn (Grasha & Yangarber, 2000). Some modifications were brought into the technique in the practice process as a result of various studies conducted on the Jigsaw technique and new types of the techniques emerged. The original was the aforementioned Jigsaw-I developed by Aronson in 1978; and it was developed to new type in the form of Jigsaw II by Slavin in 1987; and later Jigsaw III developed by Stahl in 1994; Jigsaw IV developed by Holliday in 2002; Reversed Jigsaw developed by Hedeen in 2003; and the Subject Jigsaw developed by Doymus in 2007.

Basically, the assembling technique follows the same steps in all forms. Modifications made in the practice step cause new names for the techniques. Variation in practice fashion exists between the jigsaw types. Jigsaw I and Jigsaw II differ only in the fact that group competition is allowed in Jigsaw II. The basic parts of the strategies are the same. Both have the students divided into home groups and then into expert groups. The teacher gives questions for the students to answer. The students leave their home group and go to their expert group to answer the expert sheets or questions. They then return to their home group with their expert sheets answered and teach each other their respective expert sheets. Then they are tested on the material (Slavin, 1994). In jigsaw II the grades are averaged and the group with the best average score is rewarded.

Empirical evidences on the use of cooperative learning in science revealed that Jigsaw II enhanced better performance among students in physics (Gambari and Yusuf 2014; Yusuf et al., 2012), in mathematics (Saddiq et al., 2017); in language (Qiao and Jin 2010), who in their different studies reported that jigsaw II was more effective than conventional method of teaching. Contrarily, a study conducted by Şengül and Katranci (2014) on the effects of jigsaw technique on mathematics self-efficacy perceptions of seventh grade primary school students revealed that the jigsaw technique had no effects on students' mathematics self-efficacy perceptions. In addition, Shaaban (2006) found no significant difference in the achievement of students taught using Jigsaw II and those taught using discussion methods. Therefore, this study investigated the effects of Jigsaw II cooperative learning strategy on students' performance in physics in Lafiagi, Kwara State, Nigeria.

Research Questions

The following research questions were raised in the study.

1. What is the difference between the performance of students taught electric field using the Jigsaw II Cooperative Learning Strategy and those taught using Conventional Teaching Methods?
2. Is there a difference in the performance of high, medium and low scorers in the electric field when taught using Jigsaw II Cooperative Learning Strategy?

Research Hypotheses

The following research hypotheses were tested at 0.05 level of significant in the study:

$H0_1$: There is no significant difference between the performance of students taught electric field using the Jigsaw II Cooperative Learning Strategy and those taught using the Conventional Teaching Methods,

$H0_2$: There is no significant difference in the performance of high, medium and low scoring students' taught electric field using Jigsaw II Cooperative Learning Strategy.

Methodology

The design is a quasi-experimental study of a non-randomized, non-equivalent, pretest, posttest, and control group involving a 2 X 2 X 3 factorial design. This design was considered suitable for the study because intact classes were assigned to the two different groups in this study (experimental and control groups). the population for the study was all senior secondary schools in Lafiagi. The target population was all Senior Secondary School II (SSSII) students and the sample was drawn from SSSII students that offering physics. The reason for SSS II students was that they have undergone the curriculum in their SSSI and familiar with the subject. Two secondary schools were randomly selected out of seven secondary schools who were offering physics using random sampling technique. Random sampling techniques was used because it is believed to be free of bias as it gives each school an equal chance of being selected and included for participation in the sample. The two comparable intact classes consisted of 146 (68 male and 78 female) Senior Secondary School II (SSS2) students. The schools were assigned

to experimental group (n = 80) and control group (n = 66). Offering physics was drawn from two randomly selected co-educational public schools in Lafiagi, Kwara State, Nigeria. The schools were randomly assigned to experimental group (Jigsaw II Cooperative Learning Strategy, J-II-CLS) and control (Conventional Teaching Methods, CTM) groups using simple random sampling technique. The experimental group (n = 80) was taught through Jigsaw II cooperative learning strategy, and the control group (n = 66) was taught using CTM for two weeks. The data was collected through the Electric Field Performance Test (EFPT) while Jigsaw II Cooperative Learning Instructional Package on Electric Field (JIICLIPEF) was used as a treatment instrument.

The instrument used for data collection was Electric Field Performance Test (EFPT) developed by the researchers. The instrument contained 30 multiple choice items with four options. Multiple choice items questions are widely used in schools to assess students, and the ease of scoring of these tests is appealing to teachers (Quaigrain & Arhin, 2017). The test items covered all the contents of the lesson plan developed to cover the electric field (current electricity) concepts used for the study. The EFPT was validated by five experts selected from the field of physics education, test and measurement and language education units all from the University of Ilorin. The test items were thoroughly validated by various experts along with the table of specification. They were asked to comment on the quality of the questions developed and appropriateness of the language. For face validity, some questions were restructured. For content validity, the validators gave comments and suggestions for the improvement of the test developed. Their comments and suggestions were integrated into the final draft of the 30 items EFPT. A trial test was conducted on 25 students outside the sampled schools to ensure that the instrument was consistent. The reliability coefficient of the instrument was found to be 0.85 using Kuder Richardson formula 20 (K-R20) designed by the researchers. The test consists of two sections A and B. Section A contains the demographic data of the respondents which include: class and gender of the respondents while section B contains the test items drawn from electric field (current electricity) concepts in Physics. The table of specification used in constructing the EFPT centered around the topics; concepts of electric field, component parts of a simple cell and accumulator, series and parallel arrangement of cells and resistors, factors on which the resistance of a uniform wire depends, resistivity and conductivity. Well written lesson notes on the concept of electric field (current electricity) were used. The instrument (EFPT) was administered to the experimental and control groups as pre-test and post-test. The test was validated by experts before it was administered on 40 randomly selected SSS III students who were not involved in the study using a test retest method. Reliability coefficient of 0.82 was obtained using Pearson's Product Moment Correlation Coefficient.

In collecting the data for this research, the objectives and the modalities of the study were specified and an operational guide was produced before the commencement of the treatment. The researcher trained a physics teacher who taught the experimental group using jigsaw cooperative learning strategy while the control group was taught by the physics teacher in the selected school. The study lasted for two weeks, in the first week the students were informed adequately about the objective of the study and (EFPT) was administered to the two groups which served as the pretest. The essence of the pretest was to ascertain the background knowledge of the participants in both the control and experimental group before entering into

the treatment and their scores in the existing terminal result were used to categorize the students into score levels.

The second week was used to teach both the control and experimental group in a three 40 minutes lesson (per week), the control group was taught without the use of J-II-CLS. The physics teacher in the selected school taught the control group electric field (current electricity) using a lecture method. In the experimental group, the research assistant grouped the physics students heterogeneously based on their performance in the pretest. The class was referred to as Jigsaw Home Groups which consists of five (5) students in each group involving high, medium and low scorers. The same sitting arrangement was used for the Jigsaw Expert Group. The sitting arrangement was re-constructed in a semi-circular form to make it possible for cooperative learning and for the research assistant to walk across the groups. The students were asked to construct a name tags that will be used as a form of identification such as Jigsaw Home Group A (JHGA 01-05), Jigsaw Home Group B (JHGB 01- 05), Jigsaw Home Group C (JHGC 01- 05), Jigsaw Home Group D (JHGD 01- 05), and Jigsaw Home Group E (JHGE 01- 05), and that of Jigsaw Expert Group A (JEGA 01- 05), Jigsaw Expert Group B (JEGB 01- 05), Jigsaw Expert Group C (JEGC 01- 05), Jigsaw Expert Group D (JEGD 01- 05), and Jigsaw Expert Group E (JEGE 01- 05). The students were asked to assign defined roles to two members of the group (group leader and the time keeper) while others including the leader served as secretary, in order to report what has been taught to the home group. Files were provided for all students with working sheets. Cellotapes, makers of different colors and assessment forms were provided to each group in the experimental group to note remarks and observations.

The research assistant assisted the researcher in facilitating the process of using jigsaw cooperative learning strategy in conjunction with the procedural steps adapted from jigsaw steps namely:

1. The teacher facilitates the division of the students into groups of 5, students in different groups select their group leader and secretary (home group)'
2. Teacher presents the target materials and questions informed of the module to each member of the group using a random process of selecting the module. Students study the material given to them by the teacher before moving to the expert group'
3. Students with the same materials assemble together to form an expert group and also assign their group leader and time keeper. The students in this group brainstorm the materials and solve the problems given. They all act as secretary by writing down all what they have learnt so as to teach their home group. The teacher facilitates the process by moving round, by giving feedbacks on identified misconceptions.
4. Students return to their home group and teach their group members what they have learnt from the expert group. The teacher facilitates the process by moving round, by giving feedbacks on identified misconceptions.
5. Teacher evaluates the students with a quiz that each student will attempt individually. Students attempt their quiz test individually.
6. Teacher summarizes the lesson and clarifies misconceptions during the process. Students write down the difficult aspect to their note and also write down their assignment.

Teacher ensures that everybody writes in his/her notebook. The Electric Field Performance Test (EFPT) was rearranged to contain the same test items as in the pretest as posttest. The posttest was administered to both the experimental group and control group at the end of lesson of the second week.

Data Analysis

The EFPT was administered as pretest and posttest. The data collected during the study were analyzed using t- test and Analysis of Covariance (ANCOVA) using Statistical Package for Social Sciences (SPSS) version 13 at 0.05 alpha levels.

Results

Research question 1:What is the difference in the performance of students' taught electric field using the Jigsaw II Cooperative Learning Strategy and those taught using Conventional Teaching Methods?

Table 1 shows that the mean and standard deviation values of the post-test of experimental group (those taught with jigsaw II cooperative learning strategy) is 64.42 and 15.88 respectively, while that of the control group (those taught with conventional teaching methods) is 47.12 and 16.28 respectively. That is, a mean difference of 17.30 exists between the two groups.

Table 1. *Mean difference of students in experimental and control group.*

Groups	Sample (N)	Treatments					
		Pre-test			Post-test		
		Mean	Diff	SD	Mean	Diff.	SD
Jigsaw II	80	61.18		12.53	64.42		15.88
						17.30	
Conventional	66	46.83	14.35	19.52	47.12		16.28

Hypotheses H_{01}: There is no significant difference in the performance of students taught electric field using the Jigsaw II Cooperative Learning Strategy and those taught using the Conventional Teaching Methods. The t-test result in Table 2 shows that ($t_{(144)}$=6.48; p<0.05) there was a significant difference in the performance of students taught electric field with jigsaw II cooperative learning and those taught with conventional methods in favour of those taught with jigsaw II. Hence, hypothesis 1 is rejected as p-value 0.00 is less than 0.05 significant levels.

Table 2. *The t-test statistics result between students taught with Jigsaw II and those taught without it*.

Groups	N	Mean	SD	df	T	Sig.	Remark
Jigsaw II	80	64.42	15.88	144	6.48	0.00	S
Conventional	66	47.12	16.28				

$p<0.05$.

Research Question 2: Is there a difference in the performance of high, medium and low scorers in the electric field when taught using Jigsaw II Cooperative Learning Strategy? Differences exist, as revealed in Table 3, medium scorers among the students taught electric field using jigsaw II have 67.50 mean values, followed by the high scorers with 65.38 mean values. The low scorers have the lowest mean value of 59.68.

Table 3. *Mean difference of students' score-levels when taught with Jigsaw II*.

Score levels	N	Mean	SD
Low	21	59.68	18.59
Medium	20	67.50	14.50
High	39	65.38	14.80

Hypotheses H_{02}: There is no significant difference in the performance of high, medium and low scoring students taught electric field using Jigsaw II Cooperative Learning Strategy. ANCOVA statistic was used to determine where difference lies among low, medium and high scoring students when taught electric field with jigsaw II, shows that there was no significant difference ($F_{(2,76)}=0.87$; $p>0.05$) among the three levels, hence hypothesis 2 is not rejected. This is because; p-value of 0.42 is greater than 0.05 significant levels.

Table 4. *ANCOVA analysis results of students' score-levels when taught with Jigsaw II.*

Source	Type III sum of squares	df	Mean Square	F	Sig.
Corrected Model	740.10[a]	3	246.70	0.98	0.41
Intercept	2409.17	1	2409.17	9.54	0.00
Pre-test	42.77	1	42.77	0.17	0.68
Score Level	438.14	2	219.07	0.87	0.42
Error	19188.24	76	252.48		
Total	351888.89	80			

Corrected Total	19928.33	79

R Squared = .037 (Adjusted R Squared = -.001).

Discussion

The findings revealed that there was a significant difference in the performance of students taught electric field with jigsaw II cooperative learning strategy and those taught with conventional teaching methods in favour of those taught with jigsaw II. This is because, jigsaw II cooperative learning strategy allowed students to master the concept being taught and also teach other fellow students, by this, it raised their level of understanding and translates to better performance in the topic taught (electric field). This means that jigsaw II cooperative learning strategy is more effective than conventional teaching methods in teaching electric fields. This agrees with the findings of Gambari and Yusuf (2014), Saddiq et al. (2017), Qiao and Jin (2010) and Yusuf et al. (2012) who in their different studies reported that jigsaw II was more effective than conventional methods of teaching. Contrarily, a study conducted by Şengül and Katranci (2014) on the effects of jigsaw technique on mathematics self-efficacy perceptions of seventh grade primary school students revealed that the jigsaw technique has no effects on students' mathematics self-efficacy perceptions. In addition, Shaaban (2006) found no significant difference in the achievement of students taught using jigsaw II and those taught using discussion methods.

The findings further indicated that there was no significant difference in the performance of students taught electric field with jigsaw II cooperative learning strategy on the basis of score level. This may be as a result of the fact that the strategy simultaneously enhances and improves the students' score as the difference in their scores is small; hence, it improves their performance together. The implication is that the low, medium and high scoring students had similar performance when taught with jigsaw II cooperative learning strategy. This is consistent with the findings of Omega (2017), who revealed no significance difference in the achievement of high, medium and low scorers, and contradicts the findings of Gambari and Yusuf (2014), Saddiq et al. (2017), Qiao and Jin (2010) and Yusuf et al. (2012), who in their different studies revealed a significance difference in the achievement of high, medium and low scorers.

The findings of this study emphasized on the teaching and learning of physics in secondary schools in Nigeria using jigsaw II cooperative learning strategy. The findings also revealed that jigsaw II cooperative learning strategy is efficient and more effective than conventional teaching methods. Furthermore, the findings provide sound empirical basis which indicate that performance of students in physics and other science subjects would be greatly improved if students are exposed to jigsaw II cooperative learning strategy

Conclusion

The following conclusions have been drawn based on the findings of this study:

1. Jigsaw II cooperative learning strategy is more effective in teaching electric field than conventional teaching methods.
2. Students' performances on the basis of score levels are similar when taught electric field with jigsaw II cooperative learning strategy.

Recommendations

The study recommends the following based on the findings of this study:

1. Teachers and facilitators are encouraged to adopt the use of Jigsaw II cooperative learning strategy to teach electric field and all other related topics in order to enhance and improved students' performance in physics.
2. Teacher-training institutions should include Jigsaw II cooperative learning strategy in their physics methodology course content. This will greatly assist in ensuring that prospective secondary school physics teachers are adequately trained on how to use the strategy in their classrooms to adequately help all students irrespective of their performance level for better understanding and performance in physics.

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