

EFFECT OF JIGSAW I COOPERATIVE LEARNING STRATEGY ON PHYSICS STUDENTS' ATTITUDES AND ACHIEVEMENT IN ELECTROMAGNETISM IN BAUCHI STATE, NIGERIA

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ABSTRACT

This study investigated the effect of jigsaw I cooperative learning strategy on physics students' attitudes and achievement in Electromagnetism in Bauchi State, Nigeria. Four research questions and four hypotheses guided the study. The study adopted a quasi-experimental research design, specifically, the pretest-posttest non-equivalent control group design in which intact groups are assigned to the experimental and control groups. The population of the study comprised of the entire 125 students (102 male students and 23 female students) of Physics Department of Aminu Saleh College of Education Azare and Adamu Tafawa Balewa College of Education, Kangere, Bauchi State from which 38 NCE II physics students were used. Two instruments were used in collecting data for the study namely; Electromagnetism Students' Achievement Test (ESAT) and Students' Attitudes towards Physics Questionnaire (SATPQ). Both instruments were validated by the experts. The reliability of the SATPQ was found to be 0.76 using Cronbach's coefficient alpha method on the Statistical package for Social Sciences (SPSS) Software Version 25; while the reliability of ESAT was found to be 0.84, using kuder-Richardson formula 20 (K-R 20). The analysis was done using the Statistical Package for Social Science (SPSS) Version 25 and 0.05 level of significance was adopted for testing the hypotheses. Descriptive statistics (mean and standard deviation) were used to answer the research questions while inferential statistics (ANCOVA) was used to test the hypotheses. The findings from the study revealed that Jigsaw I cooperative learning strategy had a significant effect on students' attitudes towards learning Electromagnetism; that is, after students were exposed to treatment using jigsaw I cooperative learning strategy they have developed better attitude towards Physics. It is also revealed that there is significant difference between the post-test mean achievement scores of the students taught Electromagnetism using jigsaw I cooperative learning strategy and their counterparts using conventional lecture method; that is Jigsaw I cooperative learning strategy enhanced students' achievement in Electromagnetism more than conventional lecture method that is popular and commonly used by Physics teachers. The findings also showed that the male students achieved slightly higher than their female counterparts after treatment. Based on the findings of the study, some recommendations were made as, seminars and workshops should be organized by professional bodies like Science Teachers Association of Nigeria (STAN) on jigsaw I cooperative learning strategy to stimulate and popularize their use in classrooms and Physics teachers should be encouraged to use jigsaw I cooperative learning strategy as a method of instruction in order to improve their teaching, students' attitude and achievement in physics.

INTRODUCTION

Physics is a branch of science which deals with the study of matter and energy and how they interact. It is the science subject that explains cause and effects relationship between matter and energy. Young and Freedman (2014) defined physics as an experimental science which tries to observe the phenomena of nature and try to find patterns and principles that relate to those

phenomena in the form of theories, physical laws or principles. Interestingly, the diversified concepts of the subject matter have made its study relevant in many disciplines, such as engineering, medicine, architecture, integrated science, chemistry, science education and mathematics.

According to Norwegian University of Science and Technology (NTNU, 2016), Physics is a natural science based on experiments, measurements and mathematical analysis with the purpose of finding quantitative physical laws for everything from the nano-world of the micro cosmos to the planets, solar systems and galaxies that occupy the macro-cosmos. The laws of nature can be used to predict the behavior of the world and all kinds of machinery. Many of the everyday technological inventions that we now take for granted resulted from discoveries in physics.

According to the National Commission for Colleges of Education NCCE (2012), the philosophy of the Nigeria Certificate in Education, (N.C.E), Physics is inspired by the desire to help students become intellectually informed in physics, and by the need to produce competent and effective teachers with good mastery of content and method, and a knowledge of the development of the learner. Despite these laudable objectives, physics seems to be inadequate in terms of students' achievement (Oniyangi, 2013).

To achieve the aforementioned objectives, cooperative learning strategies need to be employed by physics teachers. For example, Shahri, Matlabi, Esmaeili and Kianmehr (2017) state that education institutions have a key role in training a knowledgeable and skillful generation, and their effectiveness depends greatly on the methods of teaching they choose to teach their students. A good teaching method exposes the learners to challenging situations and provides them with opportunities for interaction, consultation, discussion and debate with themselves and their teachers so that they can develop their power of thinking and participation. One of the most important objectives of an education system is to help develop the power of thinking and create a meaningful learning experience in learners. When a learner can link newly-gained to previously-acquired information, the learning experience can be said to be meaningful. This view on learning and teaching, however, is in contrast with the unilateral transfer of knowledge from the teacher to the student (Vallori, 2014). Jigsaw cooperative learning may help in addressing the difficulty experienced by learners in transferring knowledge from teachers to students.

Cooperative learning is a strategy of teaching that has gained a lot of research interest in recent years. Due to its relevance, it is regarded as one of the greatest innovations in the educational system. Cooperative learning strategies are instructional techniques in which students work in small groups to help one another learn academic material. The use of these strategies has been increasing rapidly in use at all instructional levels, from elementary school to college, and in every school subject (Abdullah & Filiz, 2017). The term cooperative learning strategy may be characterized as a learning approach in which students build small mixed groups in classroom and other environments to assist each other in learning a certain academic subject according to a common objective in which the individuals' self-confidence is encouraged and their communication and interaction are developed in which problem-solving and thinking capacity are enhanced and in which students participate in learning process actively and teach each other (Maden, 2011). In this study, jigsaw cooperative learning strategy will be adopted.

The jigsaw strategy, developed by Elliot Aronson, is a group-work method for learning and participation in group learning activities. It is a cooperative learning strategy that enables each student of a group to specialize in one aspect of a learning unit to resolve a task or class project. Aronson and his post-graduate students observed classes with a typical competitive environment had effect of enmity among people, and thus jigsaw method emerged as a result of the need to transform competitive environment into collaboration. Aronson emphasizes that the jigsaw method encourages students to listen, cooperate and exchange ideas. Jigsaw a technique of collaborative learning method, is used to increase students' education and social performances. Today, jigsaw model has an increasing number of applications in academic level (Aronson & Patoe, 1996).

The jigsaw cooperative learning strategy enhances cooperative learning by making each student responsible for teaching some of the material to the group. In this strategy, students are members of two different groups, the 'home group' and the 'expert group'. Initially, students meet in their home groups and each member of the group is assigned a portion of the material to learn as an 'expert'. The home groups then break apart, like pieces of a jigsaw puzzle, and students move to expert groups, which consist of members from the home groups who have been assigned the same portion of the material. 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 portion to the rest of their group (Colossi & Zales, 2008).

Negative attitudes of students themselves have been suggested as a contributory factor to misconceptions and poor achievement in physics at tertiary level (Olusola, & Rotimi, 2012). Physics is considered as the most problematic area within the realm of science, and it traditionally attracts fewer students than chemistry and biology. Physics is perceived as a difficult course for student from secondary school to university and also for adults in graduate education. It is well known that both high school and college students find physics difficult (Adesoji, 2008).

Based on the issues discussed, this study is set to investigate the effects of jigsaw I cooperative learning strategy on College of Education students' attitudes and achievement in Electromagnetism in Bauchi State, Nigeria.

STATEMENT OF THE PROBLEM

Teaching and learning of physics in Nigerian Colleges of education is faced by myriad of challenges. For example, Wanbugu, Changeiywo and Ndiritu (2013) stated that the related literature shows that the students at tertiary level have difficulty in learning physics, develop negative attitudes towards the subject and it affects adversely their career choices. Physics has been a course that always has low enrolment and poor students' achievement in all level of education (Aina, 2013). Physics is by nature mathematical and full of measurement, this makes science educator like Omosewo (2009) regards it as a science of measurement.

Physics education is included as part of the N.C.E programme. This is because the science curriculum for basic science contains many physics topics like motion, force, energy, machines, friction, electricity, magnetism and electromagnetism. However, the performance of students in these courses has been reported to be very poor especially at the college level (Ukoh, 2012). In the study of contents analysis of students' academic performance in Basic Electronics, Aina and Akintunde (2014) concluded that students' performance in basic electronic was determined by the course content and that students have difficulty in learning some aspects basic electronics. However, method of teaching adopted by teachers for teaching these concepts is a major factor responsible for poor understanding and assimilation, as reported by Shahri, Matllabi, Esmaeili and Kianmehr (2017), that the lecture method of teaching which is commonly used by science teachers focused on hearing as the means of learning and can only be effective by 13%. The consequential effect is the continual poor achievement of physics students in the national and international examinations, which will eventually lead to low enrolment of students into physics related careers in higher institutions. This problem of students' underachievement in physics has also engaged the attention of many other scholars over the years (Gbolagade, 2009; Ukoh, 2012). Prominent among the factors which have been identified as contributing to the persistence of poor level of achievement in physics are: Inefficient teaching methods adopted by physics teachers in the field (Gbolagade, 2009), learner variables such as gender stereotype in physics and lack of confidence by physics students in their approach to tackling physics problems (Ukoh, 2012).

To overcome this problem, there is need to adopt cooperative teaching and learning strategies of the 21st century, as observed by Surian and Damini (2014) that teaching science topics needs to be implemented in learning circumstances in which students can reflect their ideas and discuss their learning with their friends and teachers, instead of well-planned lecture method. Through this and many other related studies have shown their interests in physics subject,

moreover the researcher is not aware of any study of this nature that was carried out in Aminu Saleh College of Education, Azare, Bauchi State, Nigeria. Therefore, there is need to determine the effects of jigsaw cooperative learning strategy on physics students' attitudes and achievement in Aminu Saleh College of Education, Azare, Bauchi State, Nigeria.

Aim And Objectives of the Study

The aim and objectives of this study is to investigate the effect of jigsaw I cooperative learning strategy on physics students' attitudes and achievement in Electromagnetism in Bauchi State, Nigeria.

The specific objectives of the study are to:

1. find out the effects of jigsaw I learning strategy on College of Education students' attitude towards electromagnetism.
2. determine the effect of jigsaw I learning strategy on College of Education male and female students' attitude towards electromagnetism.
3. ascertain the effect of jigsaw I learning strategy on College of Education students' achievement in electromagnetism.
4. determine the effect of jigsaw I learning strategy on College of Education male and female students' achievement in electromagnetism.

Research Questions

The following research questions were raised to guide the study:

1. What are the differences in the mean attitude scores of college of education students taught electromagnetism using Jigsaw I learning strategy and those taught using lecture method?
2. What are the differences in the mean attitude scores of college of education male and female students taught electromagnetism using Jigsaw I learning strategy?
3. What are the differences in the mean achievement scores of college of education students taught electromagnetism using Jigsaw I learning strategy and those taught using lecture method?
4. What are the differences in the mean achievement scores of college of education male and female students taught electromagnetism using Jigsaw I learning strategy?

Research Hypotheses

The following null hypotheses were tested in the study at 0.05 level of significance:

- Ho₁: There is no significant difference in the mean attitude scores of college of education students taught electromagnetism using Jigsaw I learning strategy and those taught using lecture method.
- Ho₂: There is no significant difference in the mean attitude scores of college of education male and female students taught electromagnetism using Jigsaw I learning strategy.
- Ho₃: There is no significant difference in the mean achievement scores of college of education students taught electromagnetism using Jigsaw I learning strategy and those taught using lecture method.
- Ho₄: There is no significant difference in the mean achievement scores of college of education male and female students taught electromagnetism using Jigsaw I learning strategy.

METHODOLOGY

The study employed the use of quasi-experimental research design, specifically, the pretest-posttest non-equivalent control group design in which intact groups are assigned to the

experimental and control groups. The population of the study comprised of the entire 125 students (102 male students and 23 female students) of Physics Department of Aminu Saleh College of Education Azare, and Adamu Tafawa Balewa College of Education, Kangere, Bauchi State from which 38 NCE II physics students were sampled using purposive sampling technique. A pretest was administered to both groups to determine any difference in the achievement of the groups. Only the experimental group received the treatment after which the two groups were post tested. This was done to the two groups to determine the effectiveness of the different conditions on students' achievement in physics.

Treatment was administered to the experimental group for a period of six weeks while the control group was merely engaged during the same period of weeks using the conventional lecture method. The experimental group was taught the concepts of electromagnetism twice a week using jigsaw cooperative learning strategy. In the experimental group, students were grouped into heterogeneous groups of 3 or 4 students, depending on the activities in the lesson. The Sitting arrangement in the groupings in the experimental group was structured such that students in each group could interact with one another during lesson. They were instructed to cooperate with each other in their groups, learn their portion of the given tasks and teach the others. Moreover, they were instructed to ask each other questions for clarity. After summarizing the lesson by the teacher, worksheets were marked and scored by the teacher for the various groups and given back to groups to know their scores. The Control group were also taught the same concepts twice a week, but using conventional lecture method of teaching. To ensure that the students are not aware that they will be used for experiment, the research assistants, being lecturers in the college, were used for the treatment. The researchers monitored the research assistants at the different locations. The treatment commenced a week after pretest is administered to both experimental and control groups.

Descriptive statistics (mean and standard deviation) were used to answer questions while inferential statistics (ANCOVA) was used to test the hypotheses. Two instruments were used in collecting data for the study namely; Electromagnetism Students' Achievement Test (ESAT) and Students' Attitudes towards Physics Questionnaire (SATPQ). Both instruments were validated by the experts. The analysis was done using the Statistical Package for Social Science (SPSS) Version 25 and 0.05 level of significance was adopted for testing the hypotheses. The reliability of the SATPQ was found to be 0.76 using Cronbach's coefficient alpha method on the Statistical package for Social Sciences (SPSS) Software Version 25; while the reliability of ESAT was found to be 0.84, using kuder-Richardson formula 20 (K-R 20).

RESULTS

The results of the study are presented based on the research questions and hypotheses as follow:

Research Question 1

What are the differences in the mean attitude scores of college of education students taught electromagnetism using Jigsaw I learning strategy and those taught using lecture method?

The result is presented in table 1.

Table 1: Mean Attitude Scores and Standard Deviation of Students taught Electromagnetism using Jigsaw I Learning Strategy and those taught using Lecture Method

Group	N	Pre-attitude		Post-attitude		Mean difference
		Mean	S. D	Mean	S. D	
Jigsaw Learning Strategy	20	2.46	0.83	4.33	0.11	1.84
Lecture Method	18	2.49	0.12	2.54	0.10	0.05
						1.79

The results in Table 1 revealed that, the mean pre-attitude scores for students taught electromagnetism using jigsaw I learning strategy and those taught using lecture method were 2.46 and 2.49 with standard deviation of 0.83 and 0.12 respectively. The mean post-attitude scores accordingly were 4.33 and 2.54 with standard deviation of 0.11 and 0.10 respectively. The overall mean difference between the two groups was 1.79 in favour of students taught electromagnetism using jigsaw I learning strategy. This implies that the students taught electromagnetism using jigsaw learning strategy have higher attitude toward learning than their counterparts taught electromagnetism using lecture method. The significant difference was further determined by testing the corresponding null hypothesis.

Research Question 2

What are the differences in the mean attitude scores of college of education male and female students taught electromagnetism using Jigsaw I learning strategy?

The result is presented in table 2.

Table 2: Mean Attitude Scores and Standard Deviation of Male an Female Students taught Electromagnetism using Jigsaw I Learning Strategy

Gender	N	Pre-attitude		Post-attitude		Mean difference
		Mean	S. D	Mean	S. D	
Male	15	2.47	0.59	4.32	0.11	1.85
Female	5	2.42	0.50	4.36	0.12	1.94
						0.09

Table 2 presented the mean pre-attitude and post-attitude scores and standard deviation of male and female students taught electromagnetism using jigsaw learning strategy. The analysis in table 2 revealed that the mean pre-attitude scores of male and female students was 2.47 and 2.42 with standard deviation of 0.59 and 0.50, while their mean post-attitude scores was 4.32 and 4.36 with standard deviation of 0.11 and 0.12 respectively. The mean attitude difference between male and female students was 0.09. This difference though small is in favour of the female students. This implies that female students have slightly higher attitude toward learning electromagnetism than their male counterparts when taught electromagnetism using jigsaw I learning strategy. The significant difference in the mean attitude scores was further determined by testing the null hypothesis.

Research Question 3

What are the differences in the mean achievement scores of college of education students taught electromagnetism using Jigsaw I learning strategy and those taught using lecture method?

The result is presented in table 3.

Table 3: Mean Achievement Scores and Standard Deviation of Students taught Electromagnetism using Jigsaw I Learning Strategy and those taught using Lecture Method

Group	N	Pre-test		Post-test		Mean difference
		Mean	S. D	Mean	S. D	
Jigsaw Learning Strategy	20	34.60	7.23	61.50	9.47	26.9
Lecture Method	18	33.22	7.42	40.11	11.43	6.89
						20.01

The results in Table 3 revealed that, the mean pre-test scores for students taught electromagnetism using jigsaw I learning strategy and those taught using lecture method were 34.60 and 33.22 with standard deviation of 7.23 and 7.42 respectively. The mean post-test scores accordingly were 61.50 and 40.11 with standard deviation of 9.47 and 11.43 respectively. The overall mean difference between the two groups was 20.01 in favour of students taught electromagnetism using jigsaw I learning strategy. This implies that the students taught electromagnetism using jigsaw learning strategy achieved higher than their counterparts taught electromagnetism using lecture method. The significant difference was further determined by testing the corresponding null hypothesis.

Research Question 4

What are the differences in the mean achievement scores of college of education male and female students taught electromagnetism using Jigsaw I learning strategy?
The result is presented in table 4.

Table 4: Mean Achievement Scores and Standard Deviation of Male and Female Students taught Electromagnetism using Jigsaw I Learning Strategy

Gender	N	Pre-test		Post-test		Mean difference
		Mean	S. D	Mean	S. D	
Male	15	35.60	6.74	63.73	9.35	28.13
Female	5	31.60	7.09	54.80	6.72	23.20
						4.93

Table 4 presented the pretest and posttest mean achievement scores and standard deviation of male and female students taught electromagnetism using jigsaw I learning strategy. The analysis in table 4 revealed that the pretest mean achievement scores of male and female students was 35.60 and 31.60 with standard deviation of 6.74 and 7.09, while their posttest mean achievement scores was 63.73 and 54.80 with standard deviation of 9.35 and 6.72 respectively. The mean achievement difference between male and female students was 4.93. This difference though small is in favour of the male students. This implies that male students achieved slightly higher than their female counterparts when taught electromagnetism using jigsaw I learning strategy. The significant difference in the mean achievement scores was further determined by testing the null hypothesis.

Hypothesis One

There is no significant difference in the mean attitude scores of college of education students taught electromagnetism using Jigsaw I learning strategy and those taught using lecture method. The result is presented in table 5 below.

Table 5 :Summary of Analysis of Covariance (ANCOVA) of Students' Mean Attitude Scores when taught Electromagnetism using Jigsaw I Learning Strategy and Lecture Method

Dependent Variable: Post Attitude

Source	Type III Sum of Squares	df	Mean Square	F	P	Partial Eta Squared	Decision
Corrected Model	30.524 ^a	2	15.262	1534.581	.000	.989	
Intercept	.323	1	.323	32.430	.000	.481	
Pre Attitude	.069	1	.069	6.959	.012	.166	

Group	30.153	1	30.153	3031.803	.000	.782	Rejected
Error	.348	35	.010				
Total	491.253	38					
Corrected Total	30.873	37					

a. R Squared = .989 (Adjusted R Squared = .988)

Analysis of Covariance (ANCOVA) result in table 5 revealed that the F-value (1,37) for the groups was found to be 39.016 with significant difference of P at 0.000, $P(0.000 < 0.05)$, partial $\eta^2 = 0.782$. The P-value 0.000 is less than level of significance 0.05 with a high effect size (78%). The null hypothesis is therefore, rejected. This implies that there is significant difference in the mean attitude scores of college of education students taught electromagnetism using Jigsaw I learning strategy and those taught using lecture method. Therefore, jigsaw I learning strategy is more effective than lecture method in enhancing students' attitude toward learning electromagnetism.

Hypothesis Two

There is no significant difference in the mean attitude scores of college of education male and female students taught electromagnetism using Jigsaw I learning strategy.

The result is presented in table 6 below.

Table 6: Summary of Analysis of Covariance (ANCOVA) of Male and Female Students' Mean Attitude Scores when taught Electromagnetism using Jigsaw I Learning Strategy

Dependent Variable: PostAttitudes

Source	Type III Sum of Squares	df	Mean Square	F	P	Decision
Corrected Model	.013 ^a	2	.007	.485	.624	
Intercept	.117	1	.117	8.499	.010	
PreAttitude	.008	1	.008	.582	.456	
Gender	.010	1	.010	.722	.407	Not Rejected
Error	.234	17	.014			
Total	375.514	20				
Corrected Total	.248	19				

a. R Squared = .054 (Adjusted R Squared = -.057)

Analysis of Covariance (ANCOVA) result in Table 6 revealed that F-value (1,19) for the gender was found to be .722 with significant difference of P at 0.407, $P(0.407 > 0.05)$. The P-value 0.407 is greater than level of significance 0.05. The null hypothesis is therefore not rejected. This implies that there is no significant difference in the mean attitude scores of college of education male and female students taught electromagnetism using Jigsaw I learning strategy. This implies that jigsaw I cooperative learning strategy is gender friendly strategy as it enhanced both male and female students' attitude toward learning electromagnetism.

Hypothesis Three

There is no significant difference in the mean achievement scores of college of education students taught electromagnetism using Jigsaw I learning strategy and those taught using lecture method.

Table 7: Summary of Analysis of Covariance (ANCOVA) of Students' Mean Achievement Scores when taught Electromagnetism using Jigsaw I Learning Strategy and Lecture Method

Dependent Variable: Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	P	Partial Eta Squared	Decision
Corrected Model	4354.060 ^a	2	2177.030	19.524	.000	.527	

Intercept	4730.974	1	4730.974	42.427	.000	.548	
Pretest	19.996	1	19.996	.179	.675	.005	
Group	4350.546	1	4350.546	39.016	.000	.527	Rejected
Error	3902.782	35	111.508				
Total	108528.000	38					
Corrected Total	8256.842	37					

a. R Squared = .527 (Adjusted R Squared = .500)

Analysis of Covariance (ANCOVA) result in table 7 revealed that the F-value (1,37) for the groups was found to be 39.016 with significant difference of P at 0.000, $P(0.000 < 0.05)$, partial $\eta^2 = 0.527$. The P-value 0.000 is less than level of significance 0.05 with a high effect size (53%). The null hypothesis is therefore, rejected. This implies that there is significant difference in the mean achievement scores of college of education students taught electromagnetism using Jigsaw I learning strategy and those taught using lecture method. Therefore, jigsaw I learning strategy is more effective than lecture method in enhancing students' achievement in electromagnetism.

Hypothesis Four

There is no significant difference in the mean achievement scores of college of education male and female students taught electromagnetism using Jigsaw learning strategy.

The result is presented in table 8.

Table 8: Summary of Analysis of Covariance (ANCOVA) of Male and Female Students' Achievement when taught Electromagnetism using Jigsaw I Learning Strategy

Dependent Variable: Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	P	Decision
Corrected Model	300.107 ^a	2	150.054	1.818	.192	
Intercept	2845.124	1	2845.124	34.477	.000	
Pretest	.840	1	.840	.010	.921	
Gender	288.790	1	288.790	3.500	.079	Not Rejected
Error	1402.893	17	82.523			
Total	77348.000	20				
Corrected Total	1703.000	19				

a. R Squared = .176 (Adjusted R Squared = .079)

Analysis of Covariance (ANCOVA) result in Table 8 revealed that F-value (1,19) for the gender was found to be 3.500 with significant difference of P at 0.79, $P(0.79 > 0.05)$. The P-value 0.79 is greater than level of significance 0.05. The null hypothesis is therefore not rejected. This implies that there is no statistically significant difference in the mean achievement scores of male and female students taught physics using jigsaw I cooperative learning strategy. This implies that jigsaw I cooperative learning strategy is gender friendly strategy as it equally enhanced both male and female students' achievement toward physics.

DISCUSSION

The finding from research question one revealed that after exposure to treatment using jigsaw I cooperative learning strategy their attitudes towards learning physics has increased.

Analysis from hypothesis one indicated that there is significant difference between the post-attitude mean scores of the students taught physics using jigsaw I cooperative learning strategy and their counterparts taught using conventional lecture method in Colleges of Education, in Bauchi State. . Therefore, jigsaw I learning strategy is more effective than lecture method in enhancing students' attitude toward learning electromagnetism. This finding is in line with that of Madu, Binti and Ruzlan (2018) and Gloria et al., (2019) who worked on the effect of cooperative

learning strategy and reported that students of who were taught physics using jigsaw cooperative learning strategy their attitudes have significantly increase than their counterparts who were taught using conventional lecture method. Based on this finding, it was established that jigsaw I learning strategy is more effective than lecture method in enhancing students' attitude toward learning electromagnetism.

The finding from research question two showed that the female students have slightly higher attitude toward learning electromagnetism than their male counterparts as a result of their exposure to treatment using jigsaw I cooperative learning strategy.

Analysis from hypothesis two revealed that there is no significant difference in the mean attitude scores of college of education male and female students taught electromagnetism using Jigsaw I learning strategy. This finding is in consonance with that of Gloria et al., (2019) that investigated the effect of Reversed Jigsaw Cooperative Instructional Strategy and reported that there is no significant difference in the mean attitude scores of college of education male and female students taught using Reversed Jigsaw Cooperative Instructional Strategy. Based on this finding, it was established that jigsaw I cooperative learning strategy is gender friendly strategy as it enhanced both male and female students' attitude toward learning electromagnetism.

The finding from research question three showed that the students taught Physics have higher mean achievement post-test scores as a result of their exposure to treatment using jigsaw I cooperative learning strategy.

Analysis from hypothesis three revealed that there is significant difference between the post-test mean achievement scores of the students taught physics using jigsaw I cooperative learning strategy and their counterparts taught using conventional lecture method in Colleges of Education, Bauchi State. Therefore, students who were taught Physics using jigsaw I cooperative learning strategy have higher post-test mean achievement scores than their counterparts taught using conventional lecture method. This finding is in consonance with that of Gloria et al., (2019) that investigated the effect of Reversed Jigsaw Cooperative Instructional Strategy and reported that students who were taught using jigsaw cooperative learning strategy as a medium of instruction have higher post-test mean scores than their of counterparts who were taught using conventional lecture method. Based on this finding, it was established that jigsaw I cooperative learning strategy is effective in enhancing students' Physics achievement than conventional lecture method.

The finding from research question four showed that the male students have slightly higher mean post-test scores than female students as a result of their exposure to treatment using jigsaw cooperative learning strategy.

Analysis from hypothesis four revealed that there is no significant difference in the mean achievement scores of male and female students taught electromagnetism using jigsaw I cooperative learning strategy. This result is in consonance with that of Yoruk (2016) and Yaduvanshi and Singh (2018), carried out a research on the effect of cooperative learning strategies on students' achievement and found that there was no statistically significant difference on the achievement of male and female students when jigsaw cooperative learning strategy is used as a medium of instruction. This insignificant difference might be due to students' similar developmental ability in comprehending, applying and using concepts in learning situations resulting to the almost equal levels of achievement. Based on this finding, achievement in physics and electromagnetism in particular is therefore, not dependent on gender, this implies that jigsaw I cooperative learning strategy is gender-friendly strategy that can be used to minimize gender-achievement-gap in physics.

CONCLUSION

Based on the findings and discussion from this study, it is concluded that: the use of using jigsaw I cooperative learning strategy is proven to enhanced students' attitude and achievement in physics than the use of conventional lecture method. Jigsaw cooperative learning strategy is

very effective in-terms of students' attitude and achievement irrespective of gender for it was revealed that there is no gender disparity in the male and female students' attitude and achievement when taught physics using jigsaw I cooperative learning strategy. Therefore, jigsaw I cooperative learning strategy is gender-friendly strategy as male and female students equally benefited.

The study provided evidence that jigsaw I cooperative learning strategy could be used to close the gender gap in the attitude and achievement of students in physics. It also indicated that there is no interaction effect between treatment and gender on students' achievement in physics. This implies that there is no need for separation of instructional strategy for male and female students since jigsaw cooperative learning strategy could be used successfully for the two gender. Therefore, jigsaw cooperative learning strategy can be used to address the present challenge of students' poor attitude and achievement in physics.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are put forward.

1. Professional bodies like Science Teachers Association of Nigeria (STAN) should organize seminars and workshops on jigsaw I cooperative learning strategy to stimulate and popularize their use in classrooms.
2. Physics teachers should be encouraged to use jigsaw I cooperative learning strategy as method of instruction that they can apply in order to improve their teaching, students' attitude and achievement in physics.
3. Jigsaw I cooperative learning strategy is an effective gender-friendly strategy that should be applied to maximize learning among students irrespective of their gender.

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