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EFFECTS OF JIGSAW COOPERATIVE LEARNING STRATEGY ON PHYSICS STUDENTS' ATTITUDES AND ACHIEVEMENT IN COLLEGES OF EDUCATION IN NORTH-EAST, NIGERIA

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ABSTRACT

This study is aimed at investigating the effects of jigsaw cooperative learning strategy on physics students' attitudes and achievement in Colleges of Education, North-East, Nigeria. Four research questions were answered and four hypotheses were formulated and tested at 0.05 level of significance in the study. The study adopted quasi-experimental research design, specifically, the pretest-posttest non-equivalent control group design in which intact classes were assigned to the experimental and control groups. The population of the study comprised of the entire 967 Physics students of Colleges of Education in North-eastern States of Nigeria comprising of Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe States, from which 210 NCE II physics students of Aminu Saleh College of Education, Azare Bauchi State, FCE Potiskum, Yobe State and FCE Gombe, Gombe State were sampled using purposive sampling technique. Six research assistants (two from each of the three sampled colleges) were employed to help the researchers in administering the treatments to both groups. A pre-test was conducted a week before commencement of the treatment which lasted for seven weeks. After the treatment a posttest was administered using the instruments. 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. Descriptive statistics (mean and standard deviation) were used to answer questions while inferential statistics (t-test and ANCOVA) were used to test the hypotheses. Data 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). The findings from the study revealed that Jigsaw cooperative learning strategy had a significant effect on students' attitudes towards learning. Based on the findings of the study, some recommendations were made as

seminars and workshops should be organize by professional bodies like Science Teachers Association of Nigeria (STAN) on jigsaw cooperative learning strategy to stimulate and popularize their use in classrooms and Physics teachers should be encouraged to use jigsaw cooperative learning strategy as method of instruction in order to improve their teaching, students' attitude and achievement in physics

INTRODUCTION

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. The basic laws in physics are universal, but physics in our time is such a vast field that many subfields are almost regarded as separate sciences (Norwegian University of Science and Technology , NTNU, 2016).

According to the Nigerian Meteorological Agency (NMA, 2012), Physics and Physicists in Nigeria contribute in addressing national security and sustainable development through the possession and maintenance of necessary infrastructure and knowledge for (i) telecommunication; (ii) adequate energy(electricity generation, transmission and distribution, refining and distribution of petroleum products); (iii) Agriculture and food security; (iv) transportation (air, land and sea); (v) provision of portable water; (vi) environmental management among others.

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. 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). 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 cooperative learning strategy on physics students' attitudes and achievement in North-East, Nigeria.

PROBLEM STATEMENT/ JUSTIFICATION

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 researchers are not aware of any study of this nature that was carried out in Colleges of Education, North-East, Nigeria. Therefore, there is need to determine the effects of jigsaw cooperative learning strategy on physics students' attitudes and achievement in Colleges of Education, North-East, Nigeria.

Objectives Of The Study

The aim and objectives of this study is to investigate the effects of jigsaw cooperative learning strategy on physics students' attitudes and achievement in Colleges of Education in North-East, Nigeria.

The specific objectives of the study are to:

1. find out whether the difference exists between achievement of NCE physics students before and after exposure to jigsaw cooperative learning strategy.
2. Determine whether the difference exists between achievement of students taught with jigsaw cooperative learning strategy and those taught with conventional lecture method.
3. investigate if there is difference between male and female students' achievement taught physics using jigsaw strategy in Colleges of Education in North-East, Nigeria.
4. determine whether the use of jigsaw cooperative learning strategy will change the attitudes of students towards learning physics.

Research Questions

The following research questions were raised to guide the study:

1. What is the difference between the pre-test and posttest mean achievement scores of NCE physics students exposed to jigsaw cooperative learning strategy?
2. What is the difference in the post-test mean achievement scores of students taught physics using jigsaw cooperative learning strategy and their counterparts taught using conventional lecture method in Colleges of Education in North-East, Nigeria?
3. What is the difference between the mean achievement scores of male and female students taught physics before and after using jigsaw cooperative learning strategy in Colleges of Education in North-East, Nigeria?
4. To what extent does jigsaw cooperative learning strategy influence students' attitudes towards physics in Colleges of Education in North-East, Nigeria?

Research Hypotheses

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

1. There is no significant difference between the pre-test and posttest mean achievement scores of NCE physics students exposed to jigsaw cooperative learning strategy.
2. There is no significant difference between the post-test mean achievement scores of the students taught physics using jigsaw cooperative learning strategy and their counterparts taught using conventional lecture method in Colleges of Education in North-East, Nigeria.
3. There is no significant difference between the post-test mean scores of male and female students taught physics using jigsaw strategy in Colleges of Education in North-East, Nigeria.

4. There is no significant interaction effect between treatment and gender on students' attitude towards Physics.

Methods and Procedure

The study adopted a quasi-experimental research design, specifically, the pretest-posttest non-equivalent control group design in which intact groups were assigned to the experimental and control groups. The design is appropriate for the study because the random assignment of students to either of the two groups was not possible as the researcher used the normal lecture period to administer the treatment. Two groups were used for the design. One group was assigned experimental group and the other control group.

The design is to compare the gain achievement scores in NCE physics of two groups so as to determine the effects of jigsaw cooperative learning strategy on Physics students' achievement in colleges of education, in North-East, Nigeria; and to compare the gain attitude scores towards learning Physics of two groups so as to ascertain the effects of jigsaw cooperative learning strategy on Physics students' attitudes towards learning Physics.

Population and Sample

The population for this study consists of the entire 967 Physics students of Colleges of Education in North-eastern States of Nigeria comprising of Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe States.Purposive sampling technique was used to sample the entire 210 physics students from intact classes of NCE II of Aminu Saleh College of Education, Azare, Bauchi State; Federal College of education, Potiskum, Yobe State; and Federal College of education, Gombe, Gombe State.

Two instruments were used for data collection. These instruments are Electromagnetism Students' Achievement Test (ESAT) and Students' Attitudes towards Physics Questionnaire (SATPQ).

To ensure face and content validity of Students' Attitudes towards Physics Questionnaire (SATPQ), the questionnaire were given to three experts, in Physics Education, Measurement and Evaluation and Psychology respectively. To ensure construct validity of SATPQ, factor analysis was conducted on SPSS software. This because factor analysis provides evidence of the construct validity of the questionnaire. A copy of SATPQ was given to each of the above mentioned experts for the validation alongside the objectives of the study, research questions and hypotheses.

Procedure

Two research assistants were employed in each of the three sampled colleges to help the researcher to carry out the treatment to experimental and control groups. The research

assistants were lecturers in the Department of Physics of the sampled Colleges. The researchers used six days to train the research assistants. The training was accomplished using Lecturer's Instructional Guide for Jigsaw cooperative learning strategy (LIGJ) and Lecturer's Instructional Guide for Conventional Lecture Method (LIGL), in conjunction with the lesson plans.

Prior to treatment on the experimental group, the two instruments were administered as pretest to all the sample in the two groups. This administration was done one week before starting the treatments. SATPQ was administered and retrieved before ESAT, which was administered a day after.

Treatment was administered to the experimental group for a period of seven weeks while the control group was merely engaged during the same period using the conventional lecture method. The experimental group were 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 to 5 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 group, 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 was 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 were not aware that they will be used for experiment, the research assistants, being lecturers in the sampled colleges, were used for the treatment. The researcher was monitoring the research assistants at the different locations. Treatment commenced a week after pretest was administered to both groups.

Administration of Posttest

After treatment, posttests was administered to the groups using SATPQ and ESAT. Posttests was administered so as to determine whether the experimental and control groups differ in the posttest mean scores of attitudes and achievement in the concepts of electromagnetism.

Descriptive statistics (mean and standard deviation) using Statistical Package for Social Sciences (SPSS) software was employed to answer all the four research questions. Hypothesis one was tested using t-test as it is concerned with only one group (experimental group) while the remaining three hypotheses were tested using Analysis of Covariance (ANCOVA), which is a parametric test, on the SPSS version. In this case,

ANCOVA was used because, apart from covering the after-effect of the different treatments, it is interested in the initial ability of the subjects (Sidhu, 2007). This shows that both pretest and posttest scores were taken into consideration in testing the formulated hypotheses.

Results

The results are analyzed and presented under research questions and hypotheses.

Research Question 1: What is the mean achievement scores of students in physics before and after exposure to jigsaw cooperative learning strategy?

Table 1: Students Mean Achievement Scores Before and After Exposure to Jigsaw Cooperative Learning Strategy

Group	Test	N	Mean	S. D	Mean difference
	Before	60	37.50	5.74	
Jigsaw Cooperative Learning Strategy					27.40
	After	60	64.93	7.62	

Table 1 revealed that the achievement mean scores of students before and after exposure to jigsaw cooperative learning strategy was 37.50 and 64.93 with standard deviation of 5.74 and 7.62 respectively with mean achievement difference of 27.40 in favour of after exposure to jigsaw cooperative learning strategy. This indicated that after exposure to treatment using exposure to jigsaw cooperative learning strategy the achievement has increased.

Research Question 2: What is the difference in the post-test mean achievement scores of students taught physics using jigsaw cooperative learning strategy and their counterparts taught using conventional lecture method?

Table 2: Post-test Mean Achievement Scores of Students taught Physics using Jigsaw Cooperative Learning Strategy and those taught using Conventional Lecture Method

Group	N	Mean	S. D	Mean difference
Jigsaw Cooperative Learning Strategy	60	64.93	7.62	
				23.01
Conventional Lecture Method	50	41.92	9.61	

Table 2 presented that the post-test mean achievement scores of students taught Physics using jigsaw cooperative learning strategy and those taught using conventional lecture

method was of 64.93 and 41.92 with standard deviation of 7.62 and 9.61 respectively with mean achievement difference of 23.01 in favour of students who were exposed to jigsaw cooperative learning strategy. This indicated that jigsaw cooperative learning strategy is more effective than conventional lecture method in enhancing students' achievement.

Research Question 3: What is the difference between the mean achievement scores of male and female students taught physics before and after using jigsaw cooperative learning strategy?

Table 3: Mean Achievement Scores and Standard Deviation of Male and Female Students

Gender	N	Before		After		
		Mean	S. D	Mean	S. D	Mean difference
Male	45	38.13	5.93	66.00	7.87	27.87
Female	15	35.60	4.79	61.73	5.95	26.13
						1.74

The results in Table 3 reveal that the before mean scores for male and female were 38.13 and 35.60 with standard deviation of 5.93 and 4.79 respectively while the after mean scores were 66.00 and 61.73 with standard deviation of 7.87 and 5.95 respectively. The mean difference of both genders was 1.74. 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 physics using jigsaw cooperative learning strategy.

Research Question 4

To what extent does jigsaw cooperative learning strategy influence students' attitudes towards physics?

Table 4: Mean Attitudinal Change of Students Exposure to Jigsaw Cooperative Learning Strategy

Group	N	Pre-Attitude		Post- Attitude		
		Mean	S. D	Mean	S. D	Mean diff
Jigsaw Cooperative Learning Strategy	60	2.99	0.47	4.33	0.11	1.34
Conventional Lecture Method	50	2.65	0.12	2.78	0.05	0.13
						1.21

The results in Table 4 reveal that, the pre-attitude mean scores for students taught physics using jigsaw cooperative learning strategy and conventional lecture method were 2.99 and 2.65 with standard deviation of 0.47 and 0.12 respectively. The post-attitude mean scores accordingly were 4.33 and 2.78 with standard deviation of 0.11 and 0.13 respectively. The overall mean attitude difference between the two groups was 1.21 in favour of students taught physics using jigsaw cooperative learning strategy. This implies that the students taught physics using jigsaw cooperative learning strategy has achieved higher than those taught using conventional lecture method.

4.1.2

Hypothesis One

There is no significant difference between the mean achievement scores of students in physics before and after exposure to jigsaw cooperative learning strategy.

Table 5: t-test of Independent Samples Analysis of Students' Mean Achievement Scores Before and After Exposure to Jigsaw Cooperative Learning Strategy

Group	Test	N	Mean	S. D	df.	t-value	*P-value*	Decision
	Before	60	37.50	5.74				
JCLS					118	-22.28	0.000	Rejected
	After	60	64.93	7.62				

Table 5 presented the t-test of independent sample analysis of students' mean achievement scores before and after exposure to jigsaw cooperative learning strategy. The the achievement mean scores of students before and after exposure to jigsaw cooperative learning strategy was 37.50 and 64.93 with standard deviation of 5.74 and 7.62 respectively. The mean achievement difference of the students before and after exposure to jigsaw cooperative learning strategy was 27.40. The df of 118, t-value of -22.28 and P-value of 0.000 was found. Since the P-value of 0.000 is less than the 0.05 level of significance (0.000<0.05) null hypothesis was rejected. Therefore, the null hypothesis which states that there is no significant difference between the mean achievement scores of students in physics before and after exposure to jigsaw cooperative learning strategy was rejected. This indicated that students achievement differ significantly after they were exposed to jigsaw cooperative learning strategy. This implies that jigsaw cooperative learning strategy significantly enhances students' achievement.

Hypothesis Two

There no significant difference between the post-test mean achievement scores of the students taught physics using jigsaw cooperative learning strategy and their counterparts taught using conventional lecture method.

Table 6: t-test of Independent Samples Analysis of Post-test Mean Achievement Scores of Students taught Physics using to Jigsaw Cooperative Learning Strategy and Conventional Lecture Method

Group	N	Mean	S. D	df.	t-value	*P-value*	Decision
Jigsaw Cooperative Learning Strategy	60	64.93	7.62				
				108	14.003	0.000	Rejected
Conventional Lecture Method	50	41.92	9.61				

Table 6 presented the t-test of independent sample analysis of students' mean achievement scores of students taught physics using to jigsaw cooperative learning strategy and conventional lecture method. The post-test mean scores of students taught physics using to jigsaw cooperative learning strategy and conventional lecture method was 64.93 and 41.92 with standard deviation of 7.62 and 9.61 respectively. the mean post-test difference of the students taught physics using to jigsaw cooperative learning strategy and conventional lecture method was 23.01. The df of 108, t-value of 14.003 and p-value of 0.000 was found. Since the P-value of 0.000 is less than the 0.05 level of significance (0.000<0.05) null hypothesis was rejected. therefore, the null hypothesis which states that there is no significant difference between the post-test mean achievement scores of the students taught physics using jigsaw cooperative learning strategy and their counterparts taught using conventional lecture method was rejected. This indicated that the mean post-test scores of students taught physics using to jigsaw cooperative learning strategy and those taught using conventional lecture method differ significantly. This implies that jigsaw cooperative learning strategy is more effective in enhances students' achievement than conventional lecture method.

Hypothesis Three

There is no significant difference between the post-test mean scores of male and female students taught physics using jigsaw strategy.

Table 7: Summary of Analysis of Covariance (ANCOVA) of Male and Female Students' Achievement when taught Physics using Jigsaw Cooperative Learning Strategy

Source	Type III Sum of Squares	df	Mean Square	F	*P-value*	Decision
Corrected Model	208.433[a]	2	104.217	1.845	.167	
Intercept	5168.669	1	5168.669	91.515	.000	

Pretest	3.633	1	3.633	.064	.801	
Gender	186.993	1	186.993	3.311	.074	Retained
Error	3219.300	57	56.479			
Total	256408.000	60				
Corrected Total	3427.733	59				

The Analysis of Covariance (ANCOVA) result from Table 7 revealed that F-value (1,59) for the gender was found to be 3.311 with significant difference of *P*-value at 0.74, P(0.74>0.05). The P-value 0.74 is greater than level of significance 0.05. The null hypothesis three was therefore, not rejected. This implies that there is no significant difference between the post-test mean scores of male and female students taught physics using jigsaw strategy. This implies that using jigsaw strategy is a gender friendly strategy that enhanced both male and female students' achievement in physics.

Hypothesis Four

Jigsaw strategy cooperative learning strategy does not influence students' attitude towards physics.

Table 8: Summary of Analysis of Covariance (ANCOVA) of influence of Jigsaw Cooperative Learning Strategy on Students' Attitude towards Physics

Source	Type III Sum of Squares	df	Mean Square	F	*P*-value	Decision
Corrected Model	93.922[a]	2	46.961	5925.715	.000	
Intercept	20.876	1	20.876	2634.152	.000	
Pretest	.009	1	.009	1.087	.299	
Group	77.674	1	77.674	9801.223	.000	Rejected
Error	.848	107	.008			
Total	1433.186	110				
Corrected Total	94.770	109				

The Analysis of Covariance (ANCOVA) result from Table 8 revealed that F-value (1,109) for the groups was found to be 9801.223 with significant difference of *P*-value at 0.000, P(0.000<0.05). The P-value 0.000 is less than level of significance 0.05. The null hypothesis four was therefore, rejected. This implies that jigsaw cooperative learning strategy influence students' attitude towards physics. This implies that using jigsaw

strategy influence students' attitude towards physics more than conventional lecture method.

Discussion of findings

The finding from this study revealed that, students taught physics using jigsaw cooperative learning strategy achieved significantly higher than their counterparts taught using conventional lecture method. This finding agreed with the position of (Johnson & Lawal, 2022; Phuntsho & Gyeltshen, 2022) in their separate studies found that students who were taught using jigsaw cooperative learning strategy achieved higher than their counterparts taught using conventional lecture method. Based on this finding it was established that, jigsaw cooperative learning strategy has more impact than conventional lecture method in enhancing students' achievement.

The finding revealed that, students taught physics using jigsaw cooperative learning strategy have positive attitude toward physics than their counterparts taught using conventional lecture method. This finding is in accord with that of (Abobaker & Abdel Rahman, 2019; Abdel-Mordy, Sabry & Mahmoud, 2022) found that students who were taught using jigsaw cooperative learning strategy have positive attitude than their counterparts of conventional lecture method. This revealed that, jigsaw cooperative learning strategy has more impact than conventional lecture method in enhancing students' attitude toward learning physics. Based on this finding, it was established that, jigsaw cooperative learning strategy enhances attitude toward learning physics better than conventional lecture method that is regularly use by physics teachers.

The finding also revealed that, there was no significant difference in male and female students' achievement scores when taught physics using jigsaw cooperative learning strategy. This finding is in agreement with that of (Suleiman, Musa & Munir, 2021; Johnson & Lawal, 2022) who in their separate studies found that gender has no effect on male and female students' achievement when using jigsaw cooperative learning strategy is used as the medium of instruction. This revealed that male and female students are capable of competing when jigsaw cooperative learning strategy is used as medium of instruction and that attitude is a function of orientation not gender. Therefore, jigsaw cooperative learning strategy is a gender-friendly instructional approach that can be used to close the gender-attitudinal gap in toward learning physics and science subjects in general.

The likely explanation for these findings may be connected to the fact that jigsaw cooperative learning strategy encourages students' active participation during the teaching and learning processes.

Summary of Findings

The following findings were made from this study:

1. After exposure to treatment using jigsaw cooperative learning strategy the achievement of students in Physics has increased.

2. Jigsaw cooperative learning strategy enhanced students' achievement in Physics more than conventional lecture method that is popular and commonly used by Physics teachers.
3. The male students achieved slightly higher than their female counterparts when taught physics using jigsaw cooperative learning strategy.
4. After students were exposed to treatment using jigsaw cooperative learning strategy they have developed better attitude toward Physics.
5. There is no significant difference between the mean achievement scores of students in physics before and after exposure to jigsaw cooperative learning strategy in Colleges of Education, North east Nigeria (0.000<0.05).
6. There is significant difference between the post-test mean achievement scores of the students taught physics using jigsaw cooperative learning strategy and their counterparts taught using conventional lecture method in Colleges of Education, North east Nigeria (0.000<0.05).
7. There is no significant difference in the mean achievement scores of male and female students taught physics using jigsaw cooperative learning strategy(0.79>0.05).
8. There is no significant interaction effect between treatment and gender on student's attitude toward Physics (0.756>0.05).

Conclusion

Based on the findings and discussion from this study, it is concluded that: the use of using jigsaw 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 cooperative learning strategy. Therefore, jigsaw cooperative learning strategy is gender-friendly strategy as male and female students equally benefited.

The study provided evidence that jigsaw 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 cooperative learning strategy to stimulate and popularize their use in classrooms.
2. Physics teachers should be encouraged to use jigsaw 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 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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