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EFFECT OF PEER-COLLABORATIVE LEARNING STRATEGY ON STUDENTS' ACADEMIC ACHIEVEMENT IN ENERGY IN BENUE STATE, NIGERIA

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Abstract

This study investigated the effect of peer-collaborative learning strategy on students' academic achievement in Energy in Benue State, Nigeria. Two research questions and two corresponding hypotheses guided the study. A quasi-experimental non-equivalent control group design was employed. The population consisted of 18,465 (9,433 male and 9,032 female) upper basic two students offering Basic Science in 162 public co-educational upper basic schools in Benue State in the 2024/2025 academic session, while the sample comprised 160 students from four intact classes drawn using multi-stage sample techniques from six co-educational schools. The Energy Achievement Test (EAT), validated by experts using a KR-21, yielded a reliability of 0.98 and was considered the instrument for data collection. Data were analyzed using mean and standard deviation to

answer the research questions, and Analysis of Covariance (ANCOVA) was used to test hypotheses. Findings revealed that peer-collaborative learning significantly enhanced students' academic achievement compared to the conventional method ($F(1, 157) = 199.773$). The study also revealed that there was no significant gender difference observed among students taught with the peer-collaborative strategy ($F(1, 68) = 0.841$). It was concluded that peer-collaborative learning is an effective strategy for improving students' achievement in the concept of Energy in Basic Science. The study recommended, among others, that peer-collaborative learning strategy should be adopted in the teaching of upper basic two students offering Basic Science across Benue State, Nigeria.

Keywords: Peer-collaborative learning, academic achievement, energy, gender and Basic Science

Introduction

Science education plays a vital role in national development, and Basic Science forms the foundation upon which scientific literacy and future specialization in disciplines such as Biology, Chemistry, and Physics are built. In Nigeria, Basic Science and Technology (BST), formerly Integrated Science, is recognized as a core subject at the basic education level (FRN, 2013). Its curriculum is designed to foster students' interest in Science and Technology, develop essential knowledge and skills, promote problem-solving and creativity, and prepare learners for further studies in the sciences (Jirgba & Bur, 2019). At the Upper Basic level, mastery of Basic Science concepts is crucial, as deficiencies at this stage often extend into senior secondary schooling and lead to low achievement in science subjects (Ajio, Ode & Kpiranyam, 2023).

Among the numerous concepts taught in Basic Science, energy is a central and increasingly important topic because of its application in daily life and its relevance to global

technological advancement. Energy is defined as the ability to do work, and is regarded as a conserved quantity fundamental to all living and non-living systems (Halliday, Resnick & Walker, 2019). Modern society depends heavily on energy transformations for transportation, communication, manufacturing, heating, cooling, and technological innovation (United States Energy Information Administration, 2023). Consequently, understanding the forms, sources, conversions, and applications of energy is essential for scientific literacy and national development.

Despite the importance of energy and other BST concepts, students' academic achievement in Basic Science in Benue State remains low, as reflected in the Basic Education Certificate Examination (BECE) results over the past six academic sessions. Data from the Benue State Examinations Board (2018–2023) show a fluctuating trend in students' pass rates, with several years recording over 50% failure in BST.

Researchers attribute this persistent underachievement to ineffective teaching methods, poor study habits, curriculum challenges, negative attitudes, and students' inability to retain learned concepts. Additionally, many Basic Science teachers teach outside their areas of specialization limiting their ability to effectively deliver complex concepts like energy. ((Ishaq, 2015); Agu & Samuel, 2018; Kanu & Agu, 2020; Ajio, Ode & Kpiranyam, 2023)

Traditionally, the demonstration method has been dominant in BST classrooms. While demonstration aids observation and skill acquisition (Basila & Jajua, 2019; Eze, Nwalo & Udu, 2021), it often keeps students passive and limits peer interaction, creativity, and problem-solving. Studies (Eggon & Agu, 2020; Ajio, Ode & Kpiranyam, 2023) have criticized the overreliance on conventional methods, especially for difficult concepts such as energy, where students require active exploration and discussion to achieve meaningful understanding.

In response to these challenges, scholars advocate for activity-based, learner-centered strategies aligned with the constructivist philosophy emphasized in the national curriculum (FRN, 2013). One of such strategies is the peer-collaborative learning strategy, a socio-cultural, constructivist approach in which students work in small groups to jointly analyze, evaluate, and solve learning tasks (Ishaq, 2015). Peer collaboration promotes social interaction, deeper cognitive processing, shared responsibility, motivation, and long-term retention (Eriba et al., 2021). Students explain concepts to one another, engage in dialogue, challenge misconceptions, and co-construct meaning processes shown to significantly enhance achievement in Basic Science (Hamilton & Telu, 2017; Adjei et al., 2020).

Ishaq (2015), Okwelle and Owo (2018), Jirgba et al. (2018), and Sylvanus (2022), reported that collaborative or cooperative learning strategies lead to higher student achievement than traditional lecture-based methods.

However, research findings on gender differences remain inconsistent, with some studies reporting male advantage (Adam, Kime & Wali, 2022), others reporting female advantage (Obodo & Ani, 2023), and still others reporting no significant difference (Sylvanus, 2022; Ishaq 2015; Jirgba et al. 2018; Eggon & Agu 2020). These inconsistencies necessitate further investigation, especially in relation to how gender interacts with peer collaboration within the context of energy learning.

The persistent students' poor performance in Basic Science, particularly in energy concepts, and the limitations associated with conventional teaching strategies, it becomes important to explore innovative pedagogies that can enhance students' achievement. Peer-collaborative learning, with its strong theoretical and empirical support, presents a promising alternative. However, there is limited evidence of its application to the teaching of energy in Benue State, Nigeria. This study therefore, examines the effect of

peer-collaborative learning strategy on students' academic achievement in the concept of energy in Benue State, Nigeria, addressing gaps in instructional practice, gender considerations, and conceptual understanding within the region.

Statement of the Problem

Energy is one of the fundamental concepts taught in Basic Science at the Upper Basic level, and students are expected to demonstrate adequate understanding and positive academic disposition toward the topic after instruction. However, evidence from classrooms and public examinations indicates that many students in Benue State, Nigeria, continue to show low academic achievement in energy-related concepts. Students often perceive energy as abstract and difficult, relying heavily on rote memorization rather than conceptual understanding. Their limited engagement, poor interaction with peers, and minimal participation during lessons further contribute to misconceptions and poor performance.

A major factor associated with these challenges is the persistent use of teacher-centered instructional methods, particularly lecture and demonstration. While these methods offer some instructional value, they generally provide few opportunities for students to collaborate, discuss ideas, ask questions, or learn actively. This lack of meaningful interaction has been linked to declining performance in Basic Science, as reflected in the fluctuating and often low Basic Education Certificate Examination (BECE) results in Benue State. The continuous poor achievement in Basic Science is worrisome, especially given that it forms the foundation for future studies in Biology, Chemistry, Physics, and other science-related fields.

Despite efforts by the government and stakeholders, such as teacher retraining programs, curriculum reforms, and increased advocacy for learner-centered approaches, the desired improvement in students' achievement has not been achieved. It has therefore become necessary to investigate alternative

instructional approaches that can enhance students' achievement in challenging concepts like energy.

Although the peer-collaborative learning strategy has been shown to improve students' achievement in various science subjects, little is known about its specific effect on students' academic achievement in the concept of energy within Benue State, Nigeria. The problem of this study is therefore expressed in this question: What is the effect of peer-collaborative learning strategy on Upper Basic II students' academic achievement in the concept of energy in Basic Science in Benue State, Nigeria?

Objective of the Study

The study was designed to determine the effect of peer-collaborative learning strategy on Upper Basic II students' academic achievement in the concept of energy in Benue State. Specifically, the study sought to:

1. determine the effect of peer-collaborative learning strategy on

students' achievement in the concept of energy in Basic Science.

2. ascertain the achievement of male and female students taught the concept of energy using the peer-collaborative learning strategy.

Research Questions

The following research questions guided the study.

1. What are the mean achievement scores of students taught energy using peer-collaborative learning strategy and those taught using the demonstration method?
2. What are the achievement scores of male and female students taught energy using peer-collaborative learning strategy?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance.

1. There is no significant difference in the mean achievement scores of students taught Basic Science using peer-collaborative learning strategy and those taught using the demonstration method.
2. There is no significant difference in the mean achievement scores of male and female students taught Basic Science using peer-collaborative learning strategy.

Methodology

The study adopted a quasi-experimental research design, specifically the non-equivalent control group design. This design was considered appropriate because the study was conducted under real school conditions, where random assignment of students to groups was not feasible. Four intact classes from selected public junior secondary schools served as the study groups. Two intact classes were assigned to the experimental group, which received instruction through the peer-collaborative learning strategy, while the other

two classes served as the control group, taught the same content using the conventional demonstration method. Both groups were exposed to a pretest–posttest structure, allowing the researcher to determine changes in students' academic achievement attributable to the instructional strategies.

The population of the study comprised of 18,465 (9,433 male and 9,032 female) upper basic Two students offering Basic Science in 162 public co-educational Upper Basic schools in Benue State in the 2024/2025 academic, while the. This population was considered suitable because the concept of energy is taught at this level under the Basic Science curriculum. From this population, a sample of sample of 160 students was drawn from four intact classes using multi-stage sample techniques. From these schools, intact classes were used as either experimental or control groups to avoid disrupting the normal school timetable and to maintain the natural classroom environment.

The instrument used for data collection was the Energy Achievement Test (EAT) developed by the researcher. The EAT consisted of 30 multiple-choice items with four options (A–D), designed to measure students' understanding of the concept of energy. The items covered essential content areas based on the Upper Basic II Basic Science curriculum. To ensure the validity of the instrument, the draft EAT was scrutinized by specialists in Science Education and experts in Measurement and Evaluation. Their suggestions contributed to refining item clarity, relevance, and content adequacy. The internal consistency of the test was determined using the Kuder–Richardson Formula 20 (KR-21), which yielded a reliability coefficient of 0.98, indicating a very high level of reliability.

The procedure for data collection was carried out in several phases. First, the researcher obtained permission from the selected schools and briefed participating teachers on the requirements of the study. Prior to the commencement of the instructional

intervention, both the experimental and control groups were administered the EAT as a pretest to determine their baseline academic achievement in the concept of energy. The treatment phase lasted for four weeks. During this period, students in the experimental group were taught using the peer-collaborative learning strategy, which involved structured group activities, discussions, peer explanations, and cooperative problem-solving. In contrast, students in the control group were taught using the demonstration method, where the teacher presented lessons and illustrated concepts while students observed. At the end of the four-week intervention, the EAT was administered again to both groups as a posttest to assess the effect

of the instructional methods on students' achievement.

Data collected from the pretests and posttests were subjected to appropriate statistical analyses. Descriptive statistics, including mean and standard deviation, were used to answer the research questions and determine patterns of achievement between the groups. To test the research hypotheses, Analysis of Covariance (ANCOVA) was employed. ANCOVA was chosen because it allowed the researcher to control for initial differences in pretest scores while determining the true effect of the instructional strategy on students' posttest achievement. All hypotheses were tested at the 0.05 level of significance.

Results

The results of the analysis are presented in tables according to the research questions and hypotheses that guided the study:

Research Question One

What are the mean achievement scores of students taught energy using peer-collaborative learning and self-regulated learning strategies and those taught using conventional method?

Table 1: Mean and Standard Deviation on Achievement Scores of Students Taught Energy Using Peer-collaborative Learning and those Taught Using Conventional Method

Group		Pre-test	Post-test
Peer-collaborative strategy	Mean	10.18	20.14
	N	71	71
	Std. Deviation	2.48	3.178
Conventional Method	Mean	12.55	16.54
	N	89	89
	Std. Deviation	3.778	3.464

Table 1 shows the mean and standard deviation of achievement scores of students taught energy using peer-collaborative strategy and conventional method. The mean of pre-test and post-test achievement scores of Peer-collaborative strategy are mean 10.18 and 20.14 while their standard deviation are 2.48 and 3.18 respectively and for the group taught using conventional method, the means of pre-test and post-test achievement scores are 12.55 and 16.54 with standard deviation of 3.78 and 3.46 respectively.

Research Question Two

What are the mean achievement scores of male and female students taught energy using peer-collaborative learning strategy?

Table 2: Mean and Standard Deviation on Achievement Scores of Male and Female Students Taught Energy Using Peer-collaborative Learning Strategy

Gender		Pretest	Posttest
Male	Mean	10.37	20.15
	N	41	41
	Std. Deviation	2.44	3.16
Female	Mean	9.93	20.13
	N	30	30
	Std. Deviation	2.56	3.26

Table 2 shows the mean and standard deviation of achievement scores of male and female students taught energy using peer-collaborative learning strategy. The means of pre-test and post-test achievement scores of male students on peer-collaborative learning strategy are Mean 10.37 and 20.15 while their standard deviations are 2.44 and 3.16

respectively. The means of pre-test and post-test achievement scores of female students taught energy using peer-collaborative learning strategy means are 9.93 and 20.13 with standard deviations 2.56 and 3.26 respectively.

Hypothesis One

There is no significant difference in the mean achievement scores of students taught energy using peer-collaborative learning and those taught using conventional method.

Table 3: Results of ANCOVA on Achievement Scores of Students Taught Energy Using Peer-collaborative Learning Strategy and those Taught Using Conventional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1477.217 ^a	2	738.608	145.359	.000	.649
Intercept	1144.455	1	1144.455	225.230	.000	.589
Pretest	964.945	1	964.945	189.903	.000	.547
Method	1015.099	1	1015.099	199.773	.000	.560
Error	797.758	157	5.081			
Total	54910.000	160				
Corrected Total	2274.975	159				

a. R Squared = .649 (Adjusted R Squared = .645)

Table 3 reveals that there is a significant difference in the mean achievement scores of students exposed to peer-collaborative and conventional method. The value of $F_{(1, 157)} = 199.773$ is obtained with associated exact probability value of 0.000. Since the associated probability value of 0.000 is less than 0.05, the null hypothesis is rejected. The results implied that, the peer-collaborative produce a significant effect on the post-test achievement scores of students when covariate effect (pre-test) is controlled. Hence, there is a significance difference among the two groups.

Hypothesis Two

There is no significant difference in the mean achievement scores of male and female students taught energy using peer-collaborative learning strategy

Table 4: Results of ANCOVA on Achievement Scores of Male and Female Students Taught Energy Using Peer-collaborative Learning Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	449.035 ^a	2	224.517	59.277	0.000	0.635
Intercept	371.067	1	371.067	97.969	0.000	0.590
Pretest	449.032	1	449.032	118.553	0.000	0.635
GenderCP	3.184	1	3.184	0.841	0.362	0.012
Error	257.557	68	3.788			
Total	29508.000	71				
Corrected Total	706.592	70				

a. R Squared = 0.635 (Adjusted R Squared = 0.625)

Table 4 reveals that; there is significant difference in the mean achievement scores of male and female students exposed to peer-collaborative learning strategy. The value of $F_{(1,68)} = 0.841$ was obtained with associated exact probability value of 0.362. Since the

associated probability 0.362 is greater than 0.05, the null hypothesis is not rejected. The results implied that, there is no gender difference in students' achievement scores in energy when they are taught with peer-collaborative learning strategy.

Discussion of Findings

The study found that the peer-collaboration learning strategy significantly improved students' achievement in the topic of energy compared to the conventional teaching method. This indicates that peer collaboration is a more effective approach for enhancing

academic performance. The improved achievement can be attributed to active engagement, shared responsibility, and deeper cognitive processing promoted by collaboration. The result agrees with earlier studies by Sylvanus (2022), Ishaq (2015), Okwelle and Owo (2018) and Jirgba et al. (2018), all of which reported that collaborative

or cooperative learning strategies lead to higher student achievement than traditional lecture-based methods.

Regarding gender, the study revealed no significant difference in the achievement of male and female students taught with the peer-collaboration strategy. This suggests that the method promotes gender equity, providing equal learning opportunities for both genders. The collaborative nature of the strategy encourages participation, communication, and shared responsibility, which minimizes gender bias. The lack of gender differences suggests that peer-collaborative learning is inclusive, providing equal learning opportunities to both male and female learners.

These findings are consistent with previous research, such as Sylvanus (2022), Ishaq (2015), Jirgba et al. (2018) and Eggon and Agu (2020), all of which reported no gender differences in academic achievement when collaborative learning strategies were used.

Conclusion

The study concluded that peer-collaborative learning strategy is highly effective in improving students' academic achievement in the concept of Energy in Benue State, Nigeria. It promotes active learning, enhances understanding and narrows gender gaps in achievement.

Recommendations

Based on the findings, the following recommendations were made:

1. Basic Science teachers should adopt peer-collaborative learning strategy regularly.
2. Curriculum planners should integrate collaborative learning activities into Basic Science curriculum.
3. Teachers should receive training and workshops on collaborative instructional strategies.

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