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EFFECTS OF PEER-COLLABORATIVE AND SELF-REGULATIVE LEARNING STRATEGIES ON STUDENTS' ATTITUDES IN THE CONCEPT OF ENERGY IN BENUE STATE, NIGERIA

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Abstract

This study investigated the effects of peer-collaborative and self-regulative learning strategies on Upper Basic II students' attitudes toward the concept of energy in Basic Science in Benue State, Nigeria. The study adopted a quasi-experimental non-equivalent control group design involving 242 students drawn from six intact classes in public junior secondary schools. Four classes were assigned to the experimental groups, which received instruction through peer-collaborative and self-regulative learning strategies, while two served as the control group and were taught using demonstration method as conventional strategy. The researcher developed the instrument, the Students' Attitude to Energy Questionnaire (SAEQ) for data collection. The instrument had a reliability coefficient of 0.94 using Cronbach's Alpha. Data were analyzed using mean and standard deviation to answer research questions and Analysis of Covariance

(ANCOVA) to test the null hypotheses at 0.05 level of significance. Findings revealed that peer-collaborative and self-regulative learning strategies significantly improved students' attitudes toward learning energy concepts compared to the conventional method. Results further showed no significant difference in the attitude ratings of male and female students taught using both strategies, indicating that the approaches promote gender equity. Based on these findings, the study concluded that learner-centered instructional strategies such as peer collaboration and self-regulation are effective in enhancing positive attitudes toward the study of energy concepts in Basic Science. The study recommended, among others, that Basic Science teachers should adopt these strategies to foster active engagement, improve students' attitudes, and support inclusive learning for all students.

Key Words: Peer-collaboration strategy, Self-regulation, attitudes, energy and gender.

Introduction

Basic Science is a foundational component of Science Education in Nigeria. It provides learners at the basic education level with the essential scientific knowledge and skills required for understanding their physical environment and for progressing to specialized sciences such as Biology, Chemistry, and Physics at the senior secondary level. As stated in the Federal Republic of Nigeria (2013), Basic Science and Technology (BST) aims to develop students' interest in science, equip them with basic scientific skills, prepare them for further studies, and enable them to meaningfully apply scientific knowledge to societal needs.

The objectives of Basic Science curriculum emphasize active participation, inquiry, problem-solving, and the development of positive attitudes toward science learning (Jirgba & Bur, 2019). However, achieving these ideals depend largely on how effectively teachers engage students using learner-centered strategies. Scholars such as Ajio, Ode and Kpiranyam (2023) highlight that meaningful achievement in senior secondary science is only possible when students develop strong foundational understanding and positive attitudes during their basic education years.

Energy is one of the core concepts taught in Basic Science. It is defined as the ability to

perform work (Halliday, Resnick & Walker, 2019). It plays a vital role in everyday life from powering machines to sustaining human and ecological systems. Despite its centrality to scientific literacy, many students struggle with understanding energy because of the abstract manner in which it is often presented. Reports from the Benue State Examinations Board (BSEB, 2018–2024) show inconsistent trends in Basic Science achievement in the Basic Education Certificate Examination (BECE). Many students record low achievement with 52.61%, 18.86%, 52.88%, 8.55%, 50.29% and 51.12% failing from 2024-2024, respectively, and this has become a source of concern for stakeholders. Persistent low achievement has been linked to numerous factors including poor instructional methods, students' negative attitudes toward science, inadequate teacher preparation, and the abstract nature of science concepts such as energy (Agu & Samuel, 2018; Tartenger, 2021).

Several scholars identify defective instructional methods particularly lecture and teacher-centered demonstration approaches as major contributors to poor achievement and negative attitudes in Basic Science (Eggon & Agu, 2020). When instruction is dominated by teacher explanations with little opportunity for interaction, students perceive science as difficult, boring, and irrelevant, leading to low

motivation, negative attitudes, and poor performance.

Given the outcomes of BECE in recent years, it is evident that a shift toward learner-centered, activity-based strategies is needed. The Nigerian curriculum encourages practical, experiential, and ICT-supported pedagogy that fosters creativity, inquiry, and problem-solving (FRN, 2013). Two strategies aligned with this philosophy are peer-collaborative learning and self-regulative learning.

Peer-collaborative learning is rooted in constructivism and socio-cultural learning theory. It involves students working together in small groups to analyze tasks, share ideas, solve problems, and explain concepts to one another (Ishaq, 2015). Research shows that collaborative learning enhances retention, promotes deeper understanding, and improves students' attitudes towards science because it allows learners to explain, listen, discuss, and actively construct knowledge (Adjei et al., 2020; Eriba et al., 2021). For instance, Atamonokhai (2018) reported that students showed significantly higher attitudes than those taught through traditional methods in Chemistry. Similarly, Money-Enwefah and Kpangban (2023) found that students exposed to self-regulative learning in Physics developed more positive attitudes and achieved

higher academic performance than those taught with lecture methods

Self-regulative learning involves students taking responsibility for planning, monitoring, and evaluating their own learning process. Maja (2018) describes it as the ability of learners to intentionally guide their thoughts, behaviors, and emotions toward achieving academic goals. In Science Education, self-regulation helps students develop independence, confidence, critical thinking, and self-motivational of which positively influence attitude and achievement (Ekuri & Offiah, 2018; Duru & Okeke, 2021;).

Attitude refers to students' feelings, beliefs, and predispositions toward learning Basic Science. It influences motivation, engagement, and achievement (Fatoba & Aladejana, 2014). A positive attitude enhances learning outcomes, while a negative attitude can hinder understanding and lead to poor achievement (Oluwatelure, 2015). An individual can display a positive or negative attitude toward a particular object, subject, or idea. John, Habil, and Rehema (2015) state that attitude indicates interest or feeling toward studying specific subjects. This reflects the overall inclination of an individual toward an object, institution, or idea. According to John, Habil, and Rehema (2015), students' attitudes can either facilitate or hinder learning. They can be positive or

negative and are related to likes or dislikes. Therefore, attitude can be seen as a positive or negative evaluation of people, objects, events, activities, ideas, or almost anything in the environment. Considering the foundational importance of Basic Science, developing positive attitudes toward key concepts like energy is crucial.

The role of gender in academic achievement and students' attitudes in Science Education and other subject areas has precipitated a variety of studies from educational researchers of different fields of endeavor. Researches on gender differences in science learning are inconsistent. Some studies report male superiority, others indicate female advantage, while many show no significant gender differences (Ezeh, 2013; Sofiani et al., 2017; Jirgba, Eriba & Achor, 2018). Empirically, Atamonokhai (2018) reported no significant gender difference in attitude among students taught with collaborative strategies, and with findings by Onwubumpe and Okigbo (2021), which also showed gender-inclusive attitudinal gains. This inconsistency necessitates further examination, particularly within the context of learner-centered strategies such as peer-collaboration and self-regulation. Given the persistent challenges in students' attitudes and performance in Basic Science, especially in energy concept and the

potential benefits of peer-collaborative and self-regulative strategies, this study sought to determine their effectiveness in Benue State.

Statement of the Problem

Despite the importance of energy as a central concept in Basic Science, many students continue to exhibit negative attitudes and low achievement in learning it. Students often rely on memorization rather than conceptual understanding because teaching approaches in many Basic Science classrooms remain teacher-centered. Limited interaction with peers and lack of opportunities for hands-on, inquiry-based learning contribute to students' perception of Basic Science concepts as difficult and abstract.

These challenges are reflected in the fluctuating and often low achievement of students in the Basic Education Certificate Examination (BECE) in Benue State. Poor attitudes and low achievement in Basic Science jeopardize students' future success in advanced science subjects and may hinder national development efforts that depend on scientific literacy. Although efforts have been made to improve science teaching through curriculum reforms and teacher training, the persistent negative attitudes and low achievement suggest that these measures have not fully addressed the problem. Empirical evidence on the effectiveness of peer-collaborative and

self-regulative learning strategies in improving students' attitudes in energy concepts in Benue State is lacking.

Therefore, the problem of this study is stated as: What are the effects of peer-collaborative and self-regulative learning strategies on students' attitudes in the concept of energy in Benue State, Nigeria, based on gender?

Objectives of the Study

The study aimed to determine the effects of peer-collaborative and self-regulative learning strategies on students' attitudes toward the concept of energy. Specifically, the study sought to:

1. determine the effects of peer-collaborative and self-regulative learning strategies on students' attitudes toward energy.
2. determine the effect of peer-collaborative learning strategy on male and female students' attitudes toward energy.
3. determine the effect of self-regulative learning strategy on male and female students' attitudes toward energy.

Research Questions

The following research questions guided the study:

1. What are the mean attitude ratings of students taught energy using peer-collaborative and self-regulative

learning strategies and those taught using the conventional method?

2. What are the mean attitude ratings of male and female students taught energy using the peer-collaborative learning strategy?
3. What are the mean attitude ratings of male and female students taught energy using the self-regulative learning strategy?

Hypotheses

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

1. There is no significant difference in the mean attitude ratings of students taught energy using peer-collaborative and self-regulative learning strategies and those taught using the conventional method.
2. There is no significant difference in the mean attitude ratings of male and female students taught energy using peer-collaborative learning strategy.
3. There is no significant difference in the mean attitude ratings of male and female students taught energy using self-regulative learning strategy.

Methodology

The study adopted a quasi-experimental non-equivalent control group design, suitable for

real school settings where randomization was not possible. Six intact classes from selected public junior secondary schools were used. Four classes formed the experimental groups taught using peer-collaborative and self-regulative learning strategies, while the remaining two classes served as the control group and were taught using the conventional demonstration method. A pre-attitude and post-attitude structure was implemented to determine changes resulting from the instructional strategies.

The population consisted of 18,465 Upper Basic II students offering Basic Science in 162 public co-educational schools in Benue State during the 2024/2025 academic session. From this population, a sample of 242 students (149 males and 93 females) was selected using multi-stage sampling. Intact classes were used to preserve the normal classroom organization. Data were collected using the Students' Attitude to Energy Questionnaire (SAEQ), a researcher-developed instrument containing 30 items scored on a four-point Likert scale. Section A gathered demographic information,

while Section B measured students' attitudes toward the concept of energy. Content and face validity were ensured through expert review, and reliability was established using Cronbach's Alpha, yielding a coefficient of 0.94.

The data collection process involved securing permission from schools, briefing teachers, and administering the SAEQ as a pre-attitude test before the four-week instructional intervention. After teaching the experimental groups with peer-collaborative and self-regulative strategies and the control group with the demonstration method, the SAEQ was re-administered as a post-attitude test.

Data analysis involved descriptive statistics (mean and standard deviation) to answer the research questions, and Analysis of Covariance (ANCOVA) to test the hypotheses. ANCOVA was used to control initial differences in pre-attitude scores and to determine the true effect of the instructional strategies. All tests were conducted at the 0.05 significance level.

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 attitude ratings 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 of Attitude Ratings of Students Taught Energy Using Peer-Collaborative Learning and Self-regulative Learning Strategies and those Taught using Conventional Method

Group		PreAttitude	PostAttitude
PC	Mean	73.49	92.63
	N	71	71
	Std. Deviation	16.08	8.41
SD	Mean	81.21	92.06
	N	78	78
	Std. Deviation	12.52	9.04
CM	Mean	76.39	85.21
	N	89	89
	Std. Deviation	17.36	9.34

Table 1 shows the mean and standard deviation of attitude ratings of students taught energy using peer-collaborative, self-regulative strategies and conventional method. The means of pre-test and post-test attitude ratings on peer-collaborative strategy are 73.49 and 76.39 while their standard deviations are 16.08 and 8.41 respectively. The means of pre-test

and post-test attitude ratings of students taught energy using self-regulative strategy are 76.39 and 85.21 with standard deviation 12.52 and 9.04 respectively, while for the group taught using conventional method, the means of pre-test and post-test attitude ratings are 76.39 and 85.21 with standard deviation of 17.36 and 9.34 respectively.

Research Question Two

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

Table 2: Mean and Standard Deviation of Mean Attitude Ratings of Male and Female Students taught Energy using Peer-collaborative Learning Strategy.

Gender PCLS		PreAttitude	PostAttitude
Male	Mean	73.78	92.44
	N	41	41
	Std. Deviation	16.43	7.29
Female	Mean	73.10	92.90
	N	30	30
	Std. Deviation	15.87	9.85

Table 2 shows the mean and standard deviation of attitude ratings of male and female students taught energy using peer-collaborative strategy. The means of pre-test and post-test attitude ratings of male students on peer-collaborative strategy are 73.78 and 92.44

while their standard deviations are 16.43 and 7.29 respectively. The means of pre-test and post-test attitude ratings of female students taught energy using peer-collaborative strategy are 73.10 and 92.90 with standard deviation 15.89 and 9.85 respectively.

Research Question Three

What are the mean attitude ratings of male and female students taught energy using self-regulative learning strategy?

Table 3: Mean and Standard Deviation on Attitude Ratings of Male and Female Students Taught Energy using Self-regulative Learning Strategy

Gender SLS		PreAttitude	PostAttitude
Male	Mean	81.12	93.12
	N	43	43
	Std. Deviation	12.36	9.18
Female	Mean	81.31	90.77
	N	35	35
	Std. Deviation	12.90	8.81

Table 3 shows the mean and standard deviation of attitude ratings of male and female students taught energy using self-regulative learning strategy. The means of pre-test and post-test attitude ratings of male students on self-regulative learning strategy are 81.12 and

93.12 while their standard deviations are 12.36 and 9.18 respectively. The means of pre-test and post-test attitude ratings of female students taught energy using self-regulative learning strategy means are 81.31 and 90.77 with standard deviation 12.90 and 8.81 respectively.

Hypothesis One

There is no significant difference in the mean attitude ratings of students taught energy using peer-collaborative learning and self-regulative learning strategies and those taught using conventional method.

Table 4: Results of ANCOVA on Attitude Ratings of Students' Taught Energy Using Peer-Collaborative Learning, Self-regulative Learning Strategies and Conventional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2842.375 ^a	3	947.458	11.730	0.000	0.131
Intercept	75427.446	1	75427.446	933.861	0.000	0.800
PreAttitude	4.041	1	4.041	0.050	0.823	0.000
Group	2841.758	2	1420.879	17.592	0.000	0.131
Error	18900.062	234	80.769			
Total	1935528.000	238				
Corrected Total	21742.437	237				

a. R Squared = 0.131 (Adjusted R Squared = 0.120)

Table 4 reveals that, there is a significant difference in the mean attitude ratings of students exposed to peer-collaborative, self-regulative and conventional method. The value of $F_{(2, 234)} = 17.592$ 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 and self-regulative produce a significant effect on the post-test attitude ratings of students when covariate effect (pre-test) is controlled. Hence, there is a significance difference among the three groups.

Hypothesis Two

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

Table 5: Results of ANCOVA on Attitude Ratings 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	9.545 ^a	2	4.773	0.066	0.936	0.002
Intercept	28271.646	1	28271.646	389.406	0.000	0.851
Pre Attitude	5.864	1	5.864	0.081	0.777	0.001
Gender CP	3.487	1	3.487	0.048	0.827	0.001
Error	4936.934	68	72.602			
Total	614199.000	71				
Corrected Total	4946.479	70				

a. R Squared = 0.002 (Adjusted R Squared = -0.027)

Table 5 reveals that; there is significant difference in the mean attitude ratings of male and female students exposed to peer-collaborative learning strategy. The value of $F_{(1,68)} = 0.048$ was obtained with associated exact probability value of 0.827. Since the

associated probability 0.827 was greater than 0.05, the null hypothesis is not rejected. The results implied that, there is no gender difference in students' attitude ratings in energy when they are taught with peer-collaborative learning strategy.

Hypothesis Three

There is no significant difference in the mean attitude ratings of male and female students taught energy using self-regulative learning strategy.

Table 6: Results of ANCOVA on Attitude Ratings of Male and Female Students taught Energy using Self-regulative Learning Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	139.700 ^a	2	69.850	0.852	0.431	0.022
Intercept	13735.288	1	13735.288	167.586	0.000	0.691
Pre Attitude	33.611	1	33.611	0.410	0.524	0.005
Gender SD	107.030	1	107.030	1.306	0.257	0.017
Error	6146.979	75	81.960			
Total	667399.000	78				
Corrected Total	6286.679	77				

a. R Squared = 0.022 (Adjusted R Squared = -0.004)

Table 6 reveals that there is significant difference in the mean attitude ratings of male and female students exposed to self-regulative learning strategy. The value of $F_{(1,75)} = 1.306$ was obtained with associated exact probability value of 0.257. Since the associated probability

Discussion of Findings

The findings of the study showed a significant difference in the mean attitude ratings of students taught the concept of energy using peer-collaborative and self-regulative learning strategies when compared with those taught through the conventional lecture method. This indicates that both strategies positively influenced students' attitudes toward learning energy concepts. Peer-collaborative learning may have improved students' attitudes because it promotes active participation, sharing of ideas, and group support, which in turn foster interest and motivation. Self-regulative learning, on the other hand, likely enhanced students' attitudes by helping learners set goals, monitor their progress, and apply learning strategies that suit their individual needs, leading to a greater sense of ownership and engagement.

These results align with earlier studies. Atamonokhai (2018) reported that students taught Chemistry using Collaborative

0.257 was greater than 0.05, the null hypothesis is not rejected. The results implied that, there is no gender difference in students' attitude ratings in energy when they are taught with self-regulative learning strategy.

Instructional Strategy (CIS) showed significantly higher interest than those taught through traditional methods. Similarly, Money-Enwefah and Kpangban (2023) found that students exposed to self-regulative learning in Physics developed more positive attitudes and achieved higher academic performance than those taught with lecture methods. These consistent findings across disciplines confirm that interactive and self-directed learning strategies generally improve students' attitudes.

The study also revealed no significant difference in the mean attitude ratings of male and female students taught using the peer-collaborative learning strategy. This suggests that both genders benefited equally from the approach. Peer-collaboration likely created a supportive learning atmosphere where students work together, share responsibilities, and participate equally, thereby reducing the influence of gender on attitudes. This is consistent with Atamonokhai (2018), who reported no significant gender difference in

interest among students taught with collaborative strategies, and with findings by Onwubumpe and Okigbo (2021), which also showed gender-inclusive attitudinal gains.

Similarly, the findings indicated no significant difference in the mean attitude ratings of male and female students taught using the self-regulative learning strategy. This means that self-regulative learning promotes gender equity by enabling both male and female students to develop similar attitudes toward the concept of energy. Because the strategy emphasizes personal goal setting, self-monitoring, and intrinsic motivation, its benefits are not dependent on gender. This agrees with the findings of Onwubumpe and Okigbo (2021), who reported no gender difference in attitudes among students exposed to self-regulative learning, and Money-Enwefah and Kpangban (2023), who found similar results in Physics.

Conclusion

The study establishes that peer-collaborative learning and self-regulative learning are effective, equitable, and student-friendly strategies that can enhance learners' attitudes toward scientific concepts. These strategies should, therefore, be adopted more widely in Basic Science classrooms to improve students'

interest, participation, and motivation for learning. Their integration into teaching practice has the potential to contribute significantly to improved learning outcomes and a more inclusive science education environment in Benue State and beyond.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Teachers should adopt peer-collaborative learning strategy in the teaching of Basic Science concepts, especially energy, as this strategy enhances students' attitudes, engagement, and participation.
2. Self-regulative learning should be integrated into classroom instruction, allowing students to set goals, monitor progress, and reflect on their learning. This approach promotes positive attitudes and encourages students to take ownership of their learning.
3. Teacher training and professional development programs at school and state levels should emphasize the use of learner-centered teaching strategies, including peer-collaboration and self-regulation, to improve both cognitive and affective learning outcomes.

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