



Basic Science and Technology Students' Achievement in Energy Using Jigsaw Cooperative Learning, Computer Animation, and Expository Strategies in Eket Local Government Area of Akwa Ibom State, Nigeria

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Abstract

This study aimed to compare Basic Science and Technology students' achievement in energy using jigsaw cooperative learning, animation technique, and expository learning strategies in Eket Local Government Area. 2 research questions and 2 hypotheses guided the study. A pretest-posttest quasi-experimental design was used. Nine thousand and eighty-two (9,082) BST students made up the population. Out of 9,082 Biology students, there are four thousand, eight hundred and twenty-five (4,825) female students and four thousand, two hundred and fifty-seven (4,257) male students (Eket Local Education Committee, 2023/2024 session). 245 Junior Secondary Two (JSS2) students from 3 intact classes are used. The three schools are drawn by a simple random sampling technique. A Basic Science and Technology Achievement Test (BSAT) was used in collecting data. 0.78 was the reliability coefficient obtained using Kuder-Richardson's formula 20 (KR-20). Descriptive statistics was utilized in addressing research questions, while Analysis of Covariance (ANCOVA) was applied for testing the null hypotheses at a $p \leq 0.05$ level of significance. Findings revealed a significant difference in the academic achievement of students instructed through the three strategies. Students taught with the jigsaw cooperative and computer animation had higher academic achievement when compared with students taught with the expository strategy. Gender was not a significant determinant of students' academic achievement in Basic science. Since the Jigsaw strategy significantly improved student achievement, science teachers should be made to integrate this method to foster active participation, peer teaching, and deeper conceptual understanding, especially in abstract topics like energy conservation and transformation, as a way of recommendation.

Keywords: Jigsaw, Animation, Expository, Energy, Gender, and Basic Science Technology

Introduction

Basic Science and Technology, BST, previously known as Integrated Science, is a core subject taught at all levels of universal basic education programs in Nigeria. The curriculum is designed to lay a solid foundation for the study of major science subjects such as Biology, Physics, and Chemistry. At this level, BST is considered vital by parents and school counselors for student placement in the science stream, as it serves as a prerequisite for future studies in core sciences. Beyond academic progression, the subject equips students with fundamental scientific knowledge essential for everyday life, environmental awareness, and problem-solving skills (Etiubon & Udo, 2024; Utibe & Onwioduokit, 2019).

Despite the significance of BST in fostering scientific literacy, educational institutions continue to grapple with poor student achievement in the subject. Research indicates that inadequate teaching strategies

contribute significantly to students' low performance. For instance, students' achievement in science improves significantly when they actively construct their knowledge and engage in hands-on scientific analysis (Khan, Hussain, Ali, Majoka, & Ramzan, 2021). However, poor instructional delivery methods remain a critical challenge in BST instruction, as evidenced by declining performance trends in the Junior Secondary School Certificate Examination (JSSCE). Data spanning 11 years (2014–2023) reveal that students achieved over 50% pass rates in only two years (2014 and 2017), while failure rates exceeded 50% in nine out of the 11 years. This pattern underscores the urgent need for improved teaching strategies.

Several factors contribute to students' poor achievement, including ineffective learning approaches, failure to connect with instructional methods, lack of laboratory facilities, and inadequate,

unqualified teachers (Ajayi & Ogbeba, 2017; Okwuduba, 2018; Etiubon, Etiubon & Akpan, 2021; Eden, Umoetuk & Mbuk, 2025). Additionally, psychological factors such as anxiety, teachers and students attitude, self-efficacy, motivation, interest, and self-esteem play significant roles in students' academic performance and acceptability of innovative learning strategies (Akpan, 2018; Eden & Mbuk, 2019; Eden, Mbuk, Umoetuk & Mathew, 2024; Eden, Mathew, Umoetuk & Akpan, 2024). Given the declining achievement trends, science teachers must adopt more effective and interactive teaching strategies to enhance students' understanding of BST (Njelita, 2021). Learning strategies are diverse, and their effectiveness depends on how well they are adapted to specific learning contexts. While no single strategy guarantees improved academic outcomes, research highlights practices that enhance student engagement and comprehension (Azmin, 2016). Among these, the jigsaw cooperative learning strategy, computer simulation, tutorial, educational games, drills – practice, infographics, guided discovery, computer animation, and flipped classroom strategies (Etiubon, Etiubon & Akpan, 2021; Umoetuk & Akpan, 2024; Eden, Umoetuk & Mbuk, 2025) have gained recognition for their potential in improving science instruction.

The jigsaw cooperative learning strategy is a well-established collaborative method of instruction where learners work in small groups, with every learner in charge of a particular aspect of the concept under consideration and interacting with the members of the group. The jigsaw strategy fosters mutual interest, trust, and cooperation among learners, thereby enhancing comprehension and retention of scientific concepts (Olorukooba, 2021). Studies have shown the efficacy of the jigsaw strategy of instruction. For example, an investigation conducted by Sahin (2020) aimed at evaluating the academic performance of students instructed through the jigsaw method revealed that it significantly improved both students' attitudes and academic performance. Hamadneh (2017) examined the implementation of the Jigsaw strategy in facilitating the comprehension of scientific concepts, concluding that the students' acquisition of such concepts was markedly enhanced. Yemi, Azid, and Ali (2018) explored the academic achievements of students in Mathematics through the application of the jigsaw strategy, which was determined to yield superior learning outcomes compared to conventional instructional methods. Likewise, Temesgen and Enunuwe (2016) identified that the application of the jigsaw teaching methodology resulted in a statistically significant

difference between the experimental group and the control group. This review underscored the critical role of the jigsaw cooperative strategy in influencing students' learning outcomes across various subject areas, concepts, and educational contexts. Consequently, this study aimed to assess the efficacy of the jigsaw cooperative strategy on the academic achievement of BST students concerning the concepts of energy conservation and transformation within domestic environments. Another strategy considered in this study is the computer animation strategy.

The computer animation learning strategy is another innovative approach that enhances conceptual understanding through visual representations. It is a technology of visual digital display of objects moving on a screen (Ukeh & Akpomiemie, 2025). Computer animation facilitates cognitive engagement by illustrating abstract concepts, making learning more interactive and effective. Aneke and Opara (2021) conducted a study on the efficacy of animation in the instruction of chemical bonding and determined that students exposed to animated teaching methods demonstrated superior performance and retention of the concept compared to their peers who were instructed via traditional lecture methods. Aktas et al. (2021) established that the academic performance of students was significantly enhanced through the utilization of computer animations and interactive activities centered on patterns. Bada et al. (2022) similarly concluded that students receiving instruction in agricultural science through innovative methods exhibited greater academic success relative to those taught using conventional lecture techniques. Aremu and Sangodoyin (2020) additionally identified that the application of computer animation proved to be advantageous in augmenting students' achievements in the subject of Biology. In the realm of chemistry, Falode et al. (2016) conveyed that the implementation of animation strategies resulted in improved student outcomes compared to those who were educated through lecture methods. The existing body of literature has substantiated the effectiveness of computer animation as a pedagogical tool in the teaching of concepts related to chemistry, agriculture, and biology, particularly in contrast to traditional instructional methodologies. The incorporation of computer animations has the potential to significantly enhance learners' comprehension of the principles of conservation and transformation of energy, thereby facilitating their understanding, knowledge, and application of energy use in homes. Another strategy considered in this study is the expository strategy to ascertain the level of its effectiveness compared to the

jigsaw cooperative and computer animation strategies.

Etiubon and Udo (2024) undertook a research investigation aimed at enhancing the academic performance and retention of energy concepts among science students through the implementation of scaffolding and project-based teaching methodologies as experimental groups, while the expository instructional strategy was utilized as the control group to examine the academic retention of energy concepts among senior secondary school science students. The results indicated that students who were instructed via the blended learning strategy exhibited a significantly superior retention of the concepts presented when compared to their counterparts who were taught through the expository method. Similarly, Odutuyi (2019) executed a study to explore the impact of activity-based learning strategies in conjunction with expository methods on students' academic performance and retention within the realm of Basic Science. The outcomes of the research revealed a statistically significant disparity in the academic achievement of students who were subjected to the activity-based learning approach versus those who received instruction through the expository method. Learners participating in the activity-based pedagogical approach exhibited superior levels of achievement compared to their peers engaged in the expository teaching method. The findings from these studies have indicated a statistically significant divergence in the application of various instructional strategies when juxtaposed with expository strategies. This research also aimed to explore the application of the expository strategy in the instruction of the principles of conservation and transformation of energy within the framework of Basic Science and Technology (BST). Additionally, gender was incorporated as another variable in this investigation.

Gender influence on achievement remains an inconclusive subject to date. Many researchers have demonstrated in favor of male or female students, and some others have stated that both males and females do better in the subject areas investigated (Akinsola, 2017; Eden, Umoetuk & Mbuk, 2025). For instance, Amedu (2015) conducted a study examining students' achievement in Biology utilizing the jigsaw method concerning gender, revealing that there was no statistically significant difference between the mean scores favoring the male gender. Furthermore, Adigun, Onihunwa, Irunokhai, Sada, and Adesina (2015) investigated the significance of the correlation between students' academic performances based on gender within the domain of computer science, demonstrating that gender had a significant impact.

Hamadneh (2017) explored the efficacy of the jigsaw strategy in comparison to traditional teaching methods for the acquisition of scientific concepts in the field of science. The results indicated that there were no statistically significant differences attributable to gender. Additionally, Oludipe (2022) found that there was no significant difference in academic achievement as a function of students' gender.

The gender factors have encountered disparities, such as sensitization from governments, NGOs, and scholars, but the gender disparity in BST performance continues to exist. This therefore indicates that the reasons for the disparity of gender and students' performance in BST have not been identified and therefore necessitate more research. The need to provide solutions to secondary school students' poor achievement in BST, especially on concepts relating to energy transformation and use in homes, prompted this study. It is to develop, validate, and analyze the usefulness of jigsaw cooperative learning and animation techniques on students' performance in the concept of conservation and transformation of energy in homes. Given the persistent challenges in BST instruction, this study seeks to ascertain the impact of jigsaw cooperative learning, computer animation, and expository strategies on students' achievement in the concept of energy in Basic Science Technology in the Eket Local Government Area of Akwa Ibom State.

Research Question

The following research questions were formulated to guide the study:

1. What is the difference among the mean achievement scores of students taught conservation and transformation of energy in homes, using jigsaw learning, computer animation, and expository strategies, respectively?
2. What is the difference between the mean achievement scores of male and female students taught conservation and transformation of energy in homes, using jigsaw learning, computer animation and expository strategies, respectively?

Research Hypotheses

The following null hypotheses will be tested at a 0.05 level of significance.

1. There is no significant difference among the mean achievement scores of students taught conservation and transformation of energy in homes, using jigsaw learning, computer

- animation, and expository strategies, respectively.
2. There is no significant difference between the mean achievement scores of male and female students taught conservation and transformation of energy in homes, using jigsaw learning, computer animation, and expository strategies respectively.

Method

The study utilized a quasi-experimental pretest-posttest design. The target population consisted of all Junior Secondary School 2 (JSS2) students in the Eket Local Government Area of Akwa Ibom State. This area includes thirteen (13) public co-educational secondary schools, totaling 9,082 Basic Science and Technology (BST) students. Among these students, 4,825 were female and 4,257 were male, according to records from the Eket Local Education Committee for the 2023/2024 academic session. 245 JSS2 students three intact classes constituted the study sample. These students were chosen using a simple random sampling method, specifically through balloting, from three public co-educational secondary schools in the area.

The instrument used for data collection was the Basic Science and Technology Achievement Test (BSAT). To ensure its validity, the BSAT underwent face and content validation by a BST teacher, an expert in test, measurement, and evaluation, and a

university lecturer from the Science Education Department, Faculty of Education, University of Uyo. They evaluated the instrument for clarity, relevance of distractors, suitability for the student level, and alignment with the study's objectives and research problem. A test blueprint guided the content validation. To further strengthen the instrument, a pilot test was conducted with twenty (20) students from a non-sampled school within the same local government area. The reliability of the BSAT was determined using the Kuder-Richardson Formula 20 (KR-20), yielding a coefficient of 0.78.

Each correct response on the BSAT earned one mark, while incorrect responses received zero, giving a total possible score of 50. Three research assistants were trained on the instructional strategies before the treatment phase began. The BSAT was first administered as a pretest with the help of the assistants. After three weeks of instruction, it was re-administered as a post-test in examination format. The teacher graded the responses, and the resulting scores were used to assess students' academic achievement in the topic "conservation and transformation of energy in homes." Descriptive statistics, specifically mean and standard deviation, were used to address the research questions and Analysis of Covariance (ANCOVA) to test the hypotheses at a 0.05 level of significance. A p-value >0.05 indicated acceptance of the null hypothesis, while a p-value <0.05 led to its rejection.

Result

Table 1: Mean and standard deviation of students' pre-test and post-test mean achievement scores of students taught the concept of conservation and transformation of energy in homes using Jigsaw Learning, Computer Animation, and Expository strategies

Strategy	N	Pre-test		Post-test		MD
		Mean	SD	Mean	SD	
Jigsaw cooperative	91	5.86	2.48	33.84	7.71	27.98
Computer Animation	73	6.11	3.73	32.83	6.69	26.72
Expository	81	6.05	1.77	17.25	7.33	11.02

Table 1 showed the achievement mean scores for the concept of conservation and transformation of energy in homes, using jigsaw cooperative learning, computer animation, and expository strategies to be 27.98, 26.72, and 11.02, respectively. This implies that students in jigsaw cooperative learning gained more than those using the computer animation while those taught using expository strategy had the lowest mean achievement mean gain. Table 1 also showed that the standard deviation of students taught the

concept of energy conservation and transformation using jigsaw cooperatives and computer animation and expository strategies is 7.71, 6.69, and 7.33, respectively. This indicates that the scattering of scores around the mean academic achievement scores of students was higher for students taught energy conservation and transformation using the jigsaw cooperative learning strategy, followed by those taught using the computer animation strategy and expository strategy.

Table 2: Analysis of Covariance (ANCOVA) of students' post-test achievement classified by treatment with pre-test as covariate

Source of Variance	Sum of squares	Df	Mean	F-value	P-value
Corrected model	14313.45 ^a	3	4771.15	90.44	0.00*
Pre-test (Covariate)	164.36	1	164.36	3.12	0.08 ^{NS}
Main effect (Treatment)	14194.02	2	7097.01	134.53	0.00*
Error	12713.75	241	52.75		
Corrected total	27027.20	244			

*Significant at $p < .05$

Table 2 displayed results on the differences in mean achievement scores of students taught the concept of conservation and transformation of energy in homes using jigsaw cooperative learning, computer animation, and expository strategies. The findings reveal that there is a significant difference in the mean

achievement scores among the three instructional strategies ($F\text{-value} = 134.53$; $p\text{-value} = .00$). Consequently, the first null hypothesis is rejected at the 0.05 level of significance. To determine the direction the significant difference, a post hoc analysis was conducted, as detailed in Table 3.

Table 3: Summary of LSD Posthoc pairwise comparison of students' post-test achievement classified by treatment

Treatment groups (I)	(J)	Mean Diff (I-J)	Std. Error	Level of sig.
Jigsaw Cooperative	Comp. Ani.	1.08	1.142	1.00
	Expository	16.63*	1.110	0.00
Computer Animation	Jigsaw Cooperative	-1.08	1.142	1.00
	Expository	15.56*	1.172	0.00
Expository	Jigsaw Cooperative	-16.63*	1.110	0.00
	Comp. Animation	-15.56*	1.172	0.00

*significant at $p < 0.05$

Table 3 presents the Post-Hoc analysis of the significant differences in mean achievement scores among students in the 3 strategies. The results indicate that students instructed through jigsaw cooperative learning and computer animation methods performed significantly better than those

instructed using the expository strategy. However, there was no significant difference in the achievement scores between students instructed with jigsaw cooperative learning and those instructed with computer animation.

Table 4: Mean and standard deviation of the mean achievement scores of male and female students taught the concept of conservation and transformation of energy in homes using jigsaw cooperative learning, computer animation, and expository strategies

		Pre-test			Post-test2		
Groups		N	Mean	SD	Mean	SD	MD
Jigsaw cooperative							
Male		39	4.46	2.01	28.74	5.01	24.28
Female	52	6.90	2.29	37.65	7.18	30.26	
Computer Animation							
Male		32	5.34	2.93	37.16	4.24	31.82
Female		41	6.71	4.18	29.46	6.32	22.75
Expository							
Male		29	6.45	1.88	16.17	6.09	9.72
Female		52	5.83	1.69	17.87	7.93	12.04

Results in Table 4 showed the (post-test - pre-test) mean scores of students taught the concept of conservation and transformation of energy in homes using the 3 strategies based on gender showed that the female students subjected to jigsaw cooperative learning strategies exhibited a superior mean difference of 30.26, in contrast to the male students who demonstrated a mean of 24.28. This implies that jigsaw cooperative strategy was significantly more effective in improving females' achievement

regarding the concepts of conservation and transformation of energy in homes compared to the males. Conversely, males that engaged with computer animation exhibited a greater mean gain of 31.82, as opposed to 22.75 the females. This indicates that computer animation was more successful in augmenting the scores of males relative to females. Also, the mean difference of males, 9.72 in the expository group was higher when juxtaposed with the female, 12.04.

Hypothesis Two

Table 5: 3x2 Analysis of Covariance (ANCOVA) of male and female students classified by treatment groups (jigsaw cooperative learning, computer animation, and expository strategies) with pre-test as covariate

Source of Variance	Sum of squares	Df	Mean	F-value	P-value
Corrected model	17079.42 ^a	6	2846.57	68.11	0.00*
Pre-test (Covariate)	44.03	1	44.03	1.05	0.00*
Main effect (Treatment)	13456.56	2	6728.28	160.97	0.00*
Gender	35.54	1	35.54	0.85	0.36 ^{NS}
Treatment* Gender	2675.22	2	1337.61	32.00	0.00*
Error	9947.78	238	41.80		
Corrected total	27027.20	244			

*significant at $p < .05$

The findings presented in Table 5 elucidate the Analysis of Variance (ANCOVA) concerning the disparity in the mean achievement scores of male and female students instructed on the conservation and transformation of energy within domestic settings, utilizing jigsaw cooperative learning, computer animation, and expository pedagogical strategies. The analysis indicates an absence of a statistically significant influence of gender on students' academic performance ($F=85$; $P=.36$). Given that the resultant probability value of .85 exceeds the 0.05 threshold for significance established for inferential decision-making, the second null hypothesis, to be upheld.

Discussion of Findings

Findings of the study revealed that those instructed with the jigsaw cooperative learning strategy achieved the highest mean scores. This was followed by students who received instruction via computer animation, while those taught using the expository method had the lowest scores. This outcome may be linked to the nature of the jigsaw cooperative learning approach, which involves individual quizzes contributing to team scores. Such a structure motivates each student to put in greater effort, aiming to master their assigned subtopic and contribute positively to the team's overall performance, thereby leading to better academic achievement. Furthermore, the study found a

statistically significant difference in the mean achievement scores among students in the three strategies. These findings are consistent with previous research by Sahin (2020), who reported that the jigsaw cooperative learning method significantly enhanced students' learning attitudes and efficiency. Similarly, Hamadneh (2017) found statistically significant differences in students' acquisition of scientific concepts using cooperative learning strategies. Yemi et al. (2018) also found that the jigsaw strategy was better than the traditional teaching strategies in boosting students' performance. Likewise, the results align with those of Temesgen and Enunuwe (2016), which indicated a statistically significant difference between students in the intervention and the control groups.

The results between males and females revealed no significant difference. This outcome may be linked to the usefulness of the strategies employed, which likely engaged all students in the same way, resulting in comparable academic performance. The equal level of motivation among male and female learners might have also contributed to the similar achievement outcomes. These findings corroborate those of Oludipe (2022), who reported no gender difference. The findings are also consistent with the study by Hamadneh (2017), which found no statistically significant gender-based differences. However, the current study contrasts with the

findings of Adigun, Onihunwa, Irunokhai, Sada, and Adesina (2015), who observed significant gender disparities in students' academic performance in computer science. It also contradicts Amedu (2015), who's found on the effect of gender using the jigsaw method found significant differences favoring male students.

Conclusion

The findings of this study underscore the usefulness of instructional strategies, particularly the jigsaw cooperative learning approach in enhancing students' academic achievement in the concept of conservation and transformation of energy in homes. Students taught using the jigsaw method consistently outperformed those exposed to computer animation and traditional expository strategies, demonstrating the value of active, collaborative learning in fostering deeper understanding and retention. Gender appeared to have a minimal influence on students' achievement in BST. These findings reinforce the need for context-sensitive, inclusive, and student-centered teaching approaches that consider learners' backgrounds and learning environments to improve scientific understanding and achievement across diverse student populations.

Recommendation

Based on the findings of the study, it was recommended that:

1. Since the Jigsaw strategy significantly improved student achievement, science teachers should be made by the authority of schools to integrate this method to foster active participation, peer teaching, and deeper conceptual understanding, especially in abstract topics like energy conservation and transformation.
2. Although computer animation favored male students slightly, this may be due to gender-based differences in digital confidence. Therefore, targeted digital literacy training and inclusive instructional design should be implemented by professional bodies, NGOs and other stakeholders to ensure equitable engagement for all students, particularly female learners.

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