Basic Science and Technology Students' Scientific Literacy in Concept ofEnergy Using Jigsaw Cooperative Learning, Computer Animation and Expository Strategies in Eket Local Government Area of Akwa Ibom State

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Abstract
This study aims at investigating Basic Science and Technology students' scientific literacy in the concept of energy using jigsaw cooperative learning, computer animation and expository strategies in Eket Local Government Area of Akwa Ibom State. A quasi-experimental design of pretest-posttest design was used. The population of the study comprised of the nine thousand and eighty-two thousand (9,082) Basic science and Technology Junior Senior Secondary two students' of 2022/2023 academic session from thirteen (13) public co-educational secondary schools in Eket Local Government Area, Akwa Ibom State. The sample size used for the study was 245 Junior Secondary two (JSS2) Basic science and Technology students from three schools drawn by simple random sampling technique. Scientific Literacy Test (SLT) was the instrument used to collect data. A reliability coefficient of 0.83 was obtained using Cronbach Alpha statistics formula. Data obtained was analysed using descriptive statistics of mean and standard deviation and hypotheses were tested using Analysis of Covariance (ANCOVA) at p≤0.05 level of significance. Results of findings showed that there is no significant effect of treatment on students' mean academic achievement score with respect to scientific literacy. There was also no significant difference among the mean retention scores of students taught conservation and transformation of energy using jigsaw cooperative learning, computer animation and expository strategies with respect to scientific literacy. Based on the findings, recommendations were made among which is the need for teachers of Basic Science and Technology to integrate Jigsaw Cooperative Learning strategies into classroom instruction, especially when teaching complex concepts like energy. This strategy promotes peer collaboration, enhances critical thinking, and supports learners of varying scientific literacy levels.

Key words: Animation, Computer, Energy, Expository, Jigsaw

Introduction

According to National Academy of Sciences (2022), the fields of science, technology, and education hold paramount place in the modern world. In democratic societies, citizens to make decisions that ultimately affect their lives and these

decisions have strong scientific components. Clément (2022) posited that a scientist must be honest, modest, always critical, rejecting dogma and fraud, but being also creative, imaginative and able to work collectively. It also provides students with necessary skills for interpreting what they have learnt within their own experience. This kind of learning makes it possible for students to become self-reliant as science-related social conditions change. The importance of Basic Science and Technology in everyday life can never be over emphasized. Kabiru and Bello (2023) described Basic science as a science-based subject taught to students in their Junior Secondary School classes aimed at helping them to have a clear and a foundational knowledge of science and how it affects their daily lives. It is the bedrock which provides the required training in scientific skills to meet the growing needs of the modern society. In agreement, Guyana (2019) noted that the transformation of education, in all fields, particularly, those of medicine, engineering, electronics and aeronautics, are direct result of the knowledge acquired through Basic Science and Technology.

The application of scientific knowledge acquired through Basic Science and Technology, has helped Nigeria transform from mono-economics to an economic and industrial power house to compete effectively with developed countries. This is expected to help students develop problem-solving skills and participate in an increasingly scientific and technological world. Students are therefore encouraged to take-up science-related subjects, study and perform well. In spite of the relevance of Basic Science and Technology in the life of the society, secondary schools are yet challenged with poor academic achievement (Etiubon and Udo, 2024). Hence the inadequate use of good teaching strategies could result to the poor academic achievement of the students. Research indicates that students' achievement in science improves dramatically if they are active participants in constructing their own knowledge and using the knowledge to analyze scientific processes (Eden, Akpan & Umanah, 2023; Khan, Hussain, Ali, Majoka and Ramzan, 2021). The teacher uses practical activities to improve students' achievement in science at all levels.

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the Nigerian educational system, innovative and interactive teaching methods have become increasingly important to address gaps in student understanding and engagement (Eden, Umoetuk & Mbuk, 2025; Eze and Agboola, 2023). This study explored the use of Jigsaw Cooperative Learning, Computer Animation, and Expository Strategies in enhancing Basic Science and Technology students' scientific literacy and retention in Eket Local Government Area of Akwa Ibom State.

Jigsaw Cooperative Learning is a typical learner-centered instructional strategy where students are divided into small groups, and each member is assigned a portion of the lesson to master and subsequently teach to their peers. According to Okebukola (2020), this approach fosters collaboration, accountability, and deeper comprehension. In Basic Science and Technology education, the jigsaw method encourages students to actively construct knowledge through social interaction, making complex concepts like energy transformation more accessible and relatable. However, Ibrahim and Daramola (2022) argue that its effectiveness largely depends on each student's commitment. Weaker students may struggle with mastering their subtopics and could negatively affect the group's overall understanding. Tofi Tofi et al. (2021), found no significant difference in academic performance between male and female students taught Basic Science using the Jigsaw Cooperative-Learning Strategy, indicating the strategy's broad applicability across diverse student groups. Orji and Ogar (2023) in a study reported that jigsaw-based learning strategies significantly enhance academic achievement in Basic Science among junior secondary school students. Jinadu and Jack (2023) also found that the Jigsaw model improved students' academic achievement in Chemistry, indicating its efficacy across different science subjects.

Computer Animation on the other hand involves the use of animated graphics and simulations to illustrate scientific phenomena, making abstract concepts more concrete and easier to visualize. In science education, computer animations provide dynamic, interactive representations of concepts that are otherwise difficult to observe directly (Olufemi and Olanrewaju, 2023). This strategy is highly relevant for enhancing students' conceptual understanding, motivation, and interest, especially in a digital-savvy generation. Research shows that technical issues such as lack of infrastructure, poor electricity supply, and limited access to digital devices in many Nigerian schools can hinder its full implementation of computer animation strategy among learners (Nwosu and Udo, 2021).

Expository Strategy on the other hand is characterized by teacher-centered lectures, remains one of the most common instructional methods in Nigerian

classrooms. It allows for the rapid delivery of large amounts of content in a structured manner (Akinfe, Olofinniyi, and Fashiku, 2021). Its relevance is seen in its efficiency for covering wide syllabi within limited instructional time. However, the major demerit of the expository method is that it often promotes rote learning, discourages active student participation, and does little to foster critical thinking or problem-solving skills needed for scientific literacy (Achor and Shaibu, 2022). While Expository Strategy remains the most traditional and widely used method, where the teacher delivers content in a lecture-like format while students passively receive information, it is only efficient for covering large volumes of material in a short time, and has been criticized for promoting rote learning and failing to engage students deeply (Akinfe, Olofinniyi, and Fashiku, 2021). In teaching scientific concepts, over-reliance on expository methods can limit critical thinking and practical application of knowledge. Each of these teaching strategies holds potential in enhancing scientific literacy, however, their effectiveness is context-dependent. A balanced approach that integrates the strengths of these methods while mitigating their respective weaknesses may offer the best prospects for improving science learning outcomes and scientific literacy among Basic Science and Technology students in Nigeria.

The necessity of the scientific literacy at a time when scientific developments influence the political scene and vice versa cannot be over emphasized. Scientific literacy, is distinct from basic literacy, is usually taken to mean acquaintance with the fundamental ideas of science. The ability to at least interact with, and perhaps evaluate, the work that scientists do and the social impact that follows from it is termed scientific literacy. Scientific literacy describes the ability of an individual to understand scientific laws, theories, phenomena and things. This means that scientific literacy places responsibility on each citizen to have the necessary scientific knowledge base to make practically any informed decision of life (Dani, 2019). Scientific literacy represents the ability to also use evidence and data to evaluate the quality of the information or arguments presented by the scientists. It describes the ability of an individual to understand scientific laws, theories, phenomena and things. The process of achieving scientific literacy covers two dimensions which are curricular and methodological. The curricular dimension comprises two components namely; scientific skills and content / knowledge /information conveyed. The methodological size equally has two components, namely the applied methods and means used in the educational process for training and developing the most important skills for scientific literacy. (Abdullahi & Salihu, ,2021).

Interest in scientific literacy has grown as science is becoming more expensive, as public attitudes to it become more critical, and as official support for it came to depend more on economic opportunities than on military/industrial imperatives (John, Karina, Margaret and Judy, 2020). Scientific literacy constitutes a strategic vector in the efficiency of the pre-university education, in inter and trans-disciplinary contexts. Achieving the scientific literacy is a basic reason for all disciplines of Basic Science and Technologies taught in secondary education. However, scenarios can be developed in and outside the classroom which will require students to apply knowledge of scientific information in different ways (Eden, Uwem, Noah, 2024). Thus, this study sought to examine the scientific literacy of students across different levels and using different learning strategies.

Statement of the Problem

Scientific literacy being the ability to understand, interpret, and apply scientific concepts, is requisite for individual and national development, particularly in today's technology-driven world. However, in Nigeria, students' proficiency in scientific literacy remains unacceptably low, especially in complex concepts like the conservation and transformation of energy. Several studies have implicated the continued use of traditional, teacher-centered methods for students' poor understanding and low engagement with science content (Anyanwu and Njoku, 2023). Efforts to improve students' achievement and scientific literacy have led to this study which seeks to address the persistent low level of scientific literacy among Basic Science and Technology students in Eket Local Government Area. Therefore, this study seeks to investigate the effects of Jigsaw Cooperative Learning, Computer Animation, and Expository strategies on students' scientific literacy in Basic Science and Technology in Eket Local Government Area of Akwa Ibom State.

Purpose of the Study

This study aimed to investigate Basic Science and Technology students' scientific literacy and retention in energy using jigsaw cooperative learning, computer animation and expository strategies in Eket Local Government Area of Akwa Ibom State.

Specifically, the objectives of the study include:

1. Determine the difference in the mean achievement scores among students taught conservation and transformation of energy in homes, using Jigsaw Cooperative Learning, Computer Animation and Expository strategies, respectively based levels of scientific literacy (High, medium and low).

2. Examine the difference existing among the mean retention scores of students taught conversation and transformation of energy in homes, using Jigsaw Learning, Computer Animation and Expository strategies, respectively based on levels of scientific literacy (High, medium and low).

Research Questions

The following research questions were formulated to guide the study:

1. What are the differences in mean achievement scores of students taught t conservation and transformation of energy in homes, using Jigsaw Learning, Computer Animation and Expository strategies respectively based on levels of scientific literacy (High, medium and low)?
2. What differences exist among the mean retention scores of students taught the concept of conversation and transformation of energy in homes, using Jigsaw Learning, Computer Animation and Expository strategies, respectively, based on levels of scientific literacy (High, medium and low)?

Research Hypotheses

The following null hypotheses will test at 0.05 level of significance

1. There is no significant difference in the achievement scores among students taught conservation and transformation of energy in homes, using Jigsaw Learning, Computer Animation and Expository strategies, respectively, based on levels of scientific literacy (High, medium and low).
2. There is no significant difference among the mean retention scores of students taught the concept of conversation and transformation of energy in homes using Jigsaw Learning, Computer Animation and Expository strategies, respectively based on levels of scientific literacy (High, medium and low).

Methodology

A non-randomized, pretest-posttest design was adopted for the study. The target population comprised of all the Junior Senior Secondary two (JSS2) students in Eket Local Government Area of Akwa Ibom State. There are thirteen (13) public co-educational secondary schools with nine thousand and eighty-two thousand (9,082) Basic Science and Technology students. 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).The study sample comprised 245 Junior Secondary two (JSS2) students (male and female) in (6) intact classes. Multi- stage sampling technique was used for the study. Simple random sampling technique was used to select six (6) public

Co-educational secondary schools out of 13 public co-educational secondary schools in Eket, Akwa Ibom State through balloting. Purposive sampling technique was then used in selecting three (3) secondary school. The Scientific Literacy Test (SLT) was used to collect data for the study. The instrument was face and content validated by an experienced Junior Secondary School Teachers and two experts in Test, Measurement and Evaluation and two lecturers in the Department of Science Education in Faculty of Education, University of Uyo. The experts vetted the items for clarity of words, plausibility of the distractors, appropriateness to the level of the students, adequacy in addressing the objectives and the problem of the study. To further strengthen the research instruments, the instruments were administered to a trial test group of twenty (20) students in a school in Eket Local Government Area, but outside the sampled schools. A reliability coefficient of 0.83 was obtained using Cronbach alpha statistics formula. The SLT was scored one mark for the correct answer and zero mark for a wrong answer but the maximum score was 40 marks. The SLT was administered with the help of the research assistants to the respondents first, as pre-test. After three weeks' period of instruction by the research assistant, it was administered to the three groups in form of examination as a post-test after which the items were graded by the teacher and the scores were used to determine the level of students' scientific literacy level. A retention test was administered by the researcher after two weeks' duration. This was scored and used for the purpose of assessing students' retention of the concept of conservation and transformation of energy in homes. Descriptive statistic of mean and standard deviation was used to answer the research questions, while the hypotheses were tested using Analysis of Covariance (ANCOVA) at $p \leq 0.05$ level of significance.

Results

Research Question 1: What are the differences in the mean achievement scores among students taught the concept of conservation and transformation of energy in homes using Jigsaw Cooperative Learning, Computer Animation and Expository strategies with respect to their levels of scientific literacy (High, medium and low)?

The result of these analysis is presented in Table 1.

Table 1: Mean and standard deviation of students' pre-test and post-test mean achievement scores among students with respect to their levels of scientific literacy (High, medium and low)

			Pretest		Posttest		
Groups	**Scientific Literacy**	**N**	**Mean**	**SD**	**Mean**	**SD**	**MD**
Jigsaw	High	20	17.10	7.07	41.15	6.54	24.05
	Medium	30	14.60	6.06	31.00	4.04	16.40
	Low	41	6.38	3.18	32.41	8.32	26.03
Comp. Ani.	High	17	7.76	2.36	33.71	8.35	25.95
	Medium	37	7.86	1.91	33.71	6.55	25.85
	Low	19	6.00	2.00	31.36	5.05	25.36
Expository	High	2	9.00	0.00	18.00	9.42	9.00
	Medium	12	8.50	2.02	16.65	6.91	8.15
	Low	67	6.09	1.76	17.17	6.30	11.08

Results in Table 1 show the mean difference (posttest-pretest mean scores) for students with high scientific literacy taught the concept of conservation and transformation of energy in homes using Jigsaw Cooperative Learning, Computer Animation and Expository strategies to be 24.05, 25.95 and 9.00, respectively. Students with medium scientific literacy in Jigsaw Cooperative Learning, Computer Animation and Expository strategies had mean difference scores of 16.40, 25.85 and 8.15, respectively. Students with low scientific literacy in Jigsaw Cooperative Learning, Computer Animation and Expository strategies had mean difference scores of 26.03, 25.36 and 11.08, respectively. This indicates that students with low scientific literacy in Experimental group 1(Jigsaw cooperative learning) had the best mean difference of 26.03 followed by students with high scientific literacy in Experimental group 2 (computer animation) group with a mean difference of 25.95, and their counterpart with low scientific literacy in the control group with mean difference of 11.08.

Research Question 2: What differences exist among the mean retention scores of students taught the concept of conversation and transformation of energy in homes using Jigsaw Cooperative Learning, Computer Animation and Expository strategies given their levels of scientific literacy (High, medium and low)?

Table 2: Mean and standard deviation of students' post-test and retention mean scores among students with respect to their levels of scientific literacy (High, medium and low)

Strategy	Scientific Literacy L	N	Posttest Mean	Posttest SD	Retention Mean	Retention SD	Mean Loss
Jigsaw	High	20	41.15	6.54	39.70	9.17	-1.45
	Medium	32	31.00	4.04	28.44	7.26	-2.56
	Low	39	32.41	8.32	32.98	8.28	-0.57
Comp. Ani	High	20	33.10	8.35	28.40	10.03	-4.70
	Medium	31	33.71	6.55	29.39	6.50	-4.32
	Low	22	31.36	5.05	27.09	5.24	-4.27
Expository	High	20	18.00	9.42	15.25	7.35	-2.75
	Medium	31	16.65	6.91	14.52	1.27	-2.13
	Low	30	17.17	6.3	18.30	3.34	-1.13

Results in Table 2 show the mean difference (retention - posttest mean scores) for students with high scientific literacy taught the concept of conservation and transformation of energy in homes using Jigsaw Cooperative Learning, Computer Animation and Expository strategies to be -1.45, -4.70 and -2.75, respectively. Students with medium scientific literacy in Jigsaw Cooperative Learning, Computer Animation and Expository strategies to be -2.56, -4.32 and -2.13, respectively. Students with low scientific literacy in Jigsaw Cooperative Learning, Computer Animation and Expository strategies had mean difference scores of 0.57, -4.27 and -1.13, respectively. This indicates that students with high scientific literacy in Experimental group 1(Jigsaw cooperative learning) had the best retention mean difference of -1.45 followed by students with low scientific literacy in Experimental group 2 (computer animation) group with a retention mean difference of -4.27, and their counterpart with medium scientific literacy in the control group with mean retention difference of -2.13.

Null Hypothesis 1: There is no significant difference in the achievement scores among students taught the concept of conservation and transformation of energy in homes using Jigsaw Cooperative Learning, Computer Animation and Expository s with respect to their levels of scientific literacy (High, medium and low).

Table 3: 3x3 Analysis of Covariance (ANCOVA) of students' achievement scores with respect to scientific literacy classified by treatment with pre-test as covariate

Source of Variance	Sum of squares	Df	Mean	F-value	P-value
Corrected model	15735.44 [a]	8	1966.93	41.11	0.00
Pre-test (Covariate)	66.12	1	66.12	1.38	0.24
Main effect (Treatment)	5681.61	2	2840.80	59.37	0.01
SLT	476.24	2	238.12	4.97	0.94
Error	11291.76	236	47.85		
Corrected total	27027.20	244			

*Significant at p<.05

The results in Table 3 shows the Analysis of Variance (ANCOVA) of the effect of Jigsaw Cooperative Learning, Computer Animation and Expository strategies on students` mean academic achievement scores in conservation and transformation of energy in homes with respect to their levels of scientific literacy (High, medium and low). The result shows that there is no significant effect of treatment on students' mean academic achievement score with respect to scientific literacy (F= 4.97; p= .94). The obtained associated exact probability value of .94 is greater than .05 set as level of significance, the null hypothesis was not rejected. It therefore means that there is no significant difference in the mean academic achievement scores with respect to scientific literacy scores of students taught the concept of conservation and transformation of energy in homes using Jigsaw Cooperative Learning, Computer Animation and Expository strategies.

Null Hypothesis 2: There is no significant difference among the mean retention scores of students taught the concept of conversation and transformation of energy in homes using Jigsaw Cooperative Learning, Computer Animation and Expository strategies given their levels of scientific literacy (High, medium and low).

Table 4: 3x3 Analysis of Covariance (ANCOVA) of students' retention scores with respect to scientific literacy classified by treatment groups with post-test as covariate

Source of Variance	Sum of squares	Df	Mean	F-value	P-value
Corrected model	22233.90 [a]	8	2779.24	144.76	0.00*
Post-test (Covariate)	7942.79	1	7942.78	413.70	0.00*
Main effect (Treatment)	349.07	2	174.53	9.09	0.00*
SLT	4.03	2	2.02	0.11	0.90^{NS}
Error	4531.90	238	19.20		
Corrected total	26764.00	244			

*Significant at p<.05

The results on Table 4 show the Analysis of Variance (ANCOVA) of the difference in the mean retention scores of students taught the concept of conversation and trans of energy in homes using Jigsaw Cooperative Learning, Computer Animation and Expository strategies given their levels of scientific literacy (High, medium and low). The results show that there is no significant effect of scientific literacy on students' retention (F=.11; P=.90). Since the associated probability value of 0.11 obtained is greater than 0.05 level of significance set for decision making, the null hypothesis which states that there is no significant difference among the mean retention scores of students taught conservation and transformation of energy using jigsaw cooperative learning, computer animation and expository strategies with respect to scientific literacy was retained.

Discussion of Findings

The data revealed that students with low scientific literacy in the Jigsaw Cooperative Learning group exhibited the highest mean difference in achievement scores (26.03), surpassing their counterparts in the Computer Animation (25.36) and Expository Strategy (11.08) groups. This suggests that the Jigsaw Cooperative Learning strategy is particularly effective for students starting with lower baseline

knowledge. This aligns with the findings of Orji and Ogar (2023), who reported that Jigsaw-based learning strategies significantly enhance academic achievement in Basic Science among junior secondary school students. Similarly, Jinadu and Jack (2023) found that the Jigsaw model improved students' academic achievement in Chemistry, indicating its efficacy across different science subjects.

Students with high scientific literacy in the Jigsaw Cooperative Learning group had the least decline in retention scores (-1.45), indicating better retention compared to their peers in the Computer Animation (-4.70) and Expository Strategy (-2.75) groups. This underscores the Jigsaw Cooperative Learning strategy's effectiveness in promoting long-term understanding. Jigsaw enhances both immediate and delayed academic achievement in Basic Science. This find in in line with the study by Gladys and Jinadu (2023) which found that the Jigsaw model significantly improves students' performance in Chemistry, reinforcing the strategy's role in facilitating knowledge retention.

Despite observable differences in mean achievement and retention scores, there was no statistically significant effect of the instructional strategies on students' retention concerning their scientific literacy levels. This suggests that while Jigsaw Cooperative Learning and Computer Animation strategies show promise, their effectiveness may not be solely dependent on students' initial scientific literacy levels. This finding is in line with the study by Tofi et al. (2021), which found no significant difference in academic performance between male and female students taught Basic Science using the Jigsaw Cooperative-Learning Strategy, indicating the strategy's broad applicability across diverse student groups. The study highlights the potential of Jigsaw Cooperative Learning and Computer Animation strategies in enhancing retention among Basic Science students, particularly those with lower initial scientific literacy. While statistical analyses did not reveal significant differences, the practical implications suggest that these instructional methods can be valuable tools in science education.

Conclusion

This study investigated the effects of Jigsaw Cooperative Learning, Computer Animation, and Expository Strategy on Basic Science and Technology students' scientific literacy in the concept of energy within Eket Local Government Area of Akwa Ibom State. Findings revealed that students taught using Jigsaw Cooperative Learning and Computer Animation strategies recorded higher mean achievement scores compared to those taught using the traditional Expository Strategy, especially

among students with low and high levels of scientific literacy. In terms of retention, students in the JCL group also demonstrated better knowledge retention over time, underscoring the strategy's strength in fostering long-term learning. The study concludes that while all three strategies are relevant in science instruction, the use of Jigsaw Cooperative Learning and Computer Animation provides a more inclusive and effective approach for enhancing scientific literacy, particularly in abstract concepts such as conservation and transformation of energy.

Recommendations

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

1. Teachers of Basic Science and Technology should integrate Jigsaw Cooperative Learning strategies into classroom instruction, especially when teaching complex concepts like energy. This strategy promotes peer collaboration, enhances critical thinking, and supports learners of varying scientific literacy levels.
2. Computer Animation should be adopted to complement traditional teaching methods. Its visual and interactive features can improve comprehension and retention, especially for abstract scientific concepts such as energy transformation and conservation.
3. Continuous professional development programs should be organized by education stakeholders and curriculum planners to train science teachers on the effective implementation of Jigsaw Cooperative Learning and the use of Computer Animation in instruction.
4. Schools should be equipped with the necessary digital infrastructure (e.g., projectors, computers, and animated educational content) to support the use of Computer Animation in classroom instruction.

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