Effects of Peer-To-Peer Learning Strategy on Junior Secondary Two Students' Achievement and Retention in Basic Science and Technology in Jaba, Kaduna State, Nigeria

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Abstract
This study investigated the effects of peer-to-peer learning strategy on Junior Secondary Two (JSS II) students' achievement and retention in Basic Science and Technology in Jaba Local Government Area of Kaduna State, Nigeria. Two research questions and two corresponding hypotheses guided the study. The study adopted a quasi-experimental research design, specifically the non-equivalent pre-test, post-test control group design. The population comprised 1,404 JSS II students from 15 public junior secondary schools in Jaba Local Government Area. A sample of 181 students was selected from two public junior secondary schools using the simple random sampling technique. The experimental group was taught using the peer-to-peer learning strategy, while the control group received instruction through the conventional lecture method. Two instruments were used for data collection: The Basic Science and Technology Achievement Test (BSTAT) and the Basic Science and Technology Delayed Post-Test (BSTDP). The instruments were subjected to expert validation, while the reliability of the BSTAT was established at 0.849. Descriptive statistics of mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was proposed for testing the hypotheses at the 0.05 level of significance. The study focuses on determining whether peer-to-peer learning improves students' academic achievement and supports the retention of scientific concepts. The findings are

expected to provide evidence on the suitability of peer-to-peer learning as an alternative to teacher-centred instructional approaches in Basic Science and Technology.

Keywords: *Academic Achievement, Basic Science and Technology, Peer-to-Peer Learning, Retention.*

Introduction

Education plays an important role in developing the knowledge, skills and values required for individual and national development. Through formal education, learners acquire the competencies necessary to understand their environment, solve problems and participate meaningfully in society. Science occupies an important position in the educational system because it provides learners with the knowledge and practical skills required to understand natural phenomena and respond to everyday challenges. Science and Technology also contribute to innovation, industrial development, economic growth and national competitiveness.

In Nigeria, Basic Science and Technology is taught at the junior secondary school level to provide learners with foundational scientific knowledge, technological skills and positive attitudes towards science-related disciplines. The subject introduces students to scientific concepts and processes that prepare them for further studies in Biology, Chemistry, Physics and other technology-related fields. It also encourages scientific investigation, observation, critical thinking and the application of acquired knowledge to practical situations (Chollom, 2016; Eze, 2022). Despite the importance of Basic Science and Technology, students' achievement in the subject remains a concern. One factor associated with this problem is the instructional approach adopted by teachers. In many classrooms, the lecture method remains a common teaching approach. This method places considerable responsibility on the teacher, while students often participate through listening, note-taking and memorisation. Although the lecture method can support the presentation of information within a limited period, excessive dependence on it may restrict students' opportunities to interact with learning materials, exchange ideas and develop a deeper understanding of scientific concepts. Chollom, Garba and Ozoji (2020) observed that the teaching of Basic Science and Technology in Nigerian schools is still largely characterised by teacher-centred instructional practices. Similarly, Obielodan, Onojah, Alabi and Alimi (2021) reported limited application of interactive teaching approaches in science classrooms. These practices may affect students' understanding, academic achievement and ability to retain scientific knowledge over time.

Academic achievement refers to the extent to which students demonstrate their understanding of instructional content through assessment. It provides an indication of the knowledge and competencies acquired during the teaching and learning process. Students' achievement in Basic Science and Technology is influenced by several factors, including teaching strategies, teacher competence, availability of instructional materials, students' interest and classroom interaction (Aku & Agu, 2020; Etobro & Fabinu, 2018). The Basic Education Certificate Examination (BECE) analysis of students' achievement in Basic Science and Technology from 2020–2024 in Kaduna State, particularly in Jaba Local Government Area, indicates persistently low achievement levels. For example, in 2020, a total of 995,345 students sat for the examination, and only 231,915 (23.3%) passed, while 763,430 (76.7%) failed. In 2021, 882,119 students sat for BECE, with only 277,867 (31.5%) passing, while 604,852 (68.5%) failed in all areas of Basic Science and Technology. One instructional approach that could address some of these challenges is peer-to-peer learning. Peer-to-peer learning is a student-centred instructional strategy in which learners work together to understand concepts, exchange knowledge and assist one another in completing

academic tasks. It involves structured interaction between students, with more knowledgeable or academically stronger learners providing guidance to their peers under the supervision of the teacher. According to Shahid (2024), peer-to-peer learning encourages learners to explore concepts, ask questions and develop meaningful connections through interaction. The teacher provides the necessary instructional materials, organises students into groups and guides the learning activities. Through this process, students become active participants in their learning rather than passive recipients of information. Peer-to-peer learning may improve academic achievement because students have opportunities to explain concepts in their own words, ask questions and receive immediate assistance from their classmates. Students who teach others may also strengthen their understanding of the subject through repeated explanation and discussion. Similarly, students who receive assistance from their peers may find it easier to understand difficult concepts because explanations are often presented in language and examples familiar to them.

Research has associated peer-to-peer and collaborative learning approaches with improved academic performance in science-related subjects (Aku & Agu, 2020; Avramidis et al., 2019; Thurston et al., 2021). These approaches encourage cooperation, communication and active participation, which are important components of meaningful learning. Beyond academic achievement, retention is another important outcome of the teaching and learning process. Retention refers to the ability of learners to preserve previously acquired knowledge and retrieve it when required. In Basic Science and Technology, students are expected to remember scientific concepts, principles and processes beyond the immediate classroom instruction. The ability to retain such knowledge is important because scientific learning often involves the application of previously acquired concepts to new situations.

Students' retention may be influenced by the instructional strategies used during teaching. When learners participate actively in discussions, practical activities and collaborative problem-solving, they have more opportunities to process and reinforce the information being taught. In contrast, learning that relies mainly on listening and memorisation may provide fewer opportunities for learners to practise retrieving and applying knowledge. The Forgetting Curve Theory, associated with Hermann Ebbinghaus (1885), provides a theoretical explanation of how information may be lost over time when it is not reinforced. The theory suggests that retention can be strengthened through repetition and review. In this regard, peer-to-peer learning provides opportunities for learners to revisit concepts through discussions, explanations and collaborative activities. The theoretical foundation of this study is also supported by Vygotsky's (1978) Social Constructivist Theory, which emphasises the importance of social interaction in cognitive development. According to this perspective, learners develop understanding through interaction with others who provide guidance and support. Peer-to-peer learning reflects this principle by creating opportunities for students to assist one another in understanding scientific concepts.

Although previous studies have examined collaborative learning and academic achievement, there remains a need for further investigation into the combined outcomes of achievement and retention among junior secondary school students in Basic Science and Technology, particularly in Jaba Local Government Area of Kaduna State. Examining both outcomes is important because immediate improvement in test performance does not necessarily establish that students can retain the knowledge acquired over time. Consequently, this study investigates the effects of peer-to-peer learning strategy on Junior Secondary Two students' achievement and retention in Basic Science and Technology in Jaba Local Government Area of Kaduna State, Nigeria.

Statement of the Problem

Despite the importance of Basic Science and Technology in developing scientific knowledge and technological skills, students' achievement and retention in the subject remain major concerns. Available evidence from the Basic Education Certificate Examination indicates persistent challenges in students' performance in the subject. These challenges raise questions about the effectiveness of instructional strategies employed in junior secondary schools. One possible contributing factor is the continued dependence on teacher-centred instructional approaches, particularly the lecture method. Under this approach, students may have limited opportunities to participate actively in classroom activities, discuss scientific concepts or learn through interaction with their classmates. This situation may affect their understanding of scientific concepts and their ability to retain previously acquired knowledge.

Peer-to-peer learning provides an alternative instructional approach through which students can exchange ideas, explain difficult concepts and support one another during learning activities. Although the strategy has been associated with improved academic performance, its effects on both achievement and delayed retention among JSS II students in Basic Science and Technology in Jaba Local Government Area require further empirical investigation. The problem of this study, therefore, is whether the use of peer-to-peer learning strategy can improve students' achievement and retention in Basic Science and Technology compared with the conventional lecture method.

Aim and Objectives of the Study

The aim of this study is to investigate the effects of peer-to-peer learning strategy on Junior Secondary Two students' achievement and retention in Basic Science and Technology in Jaba Local Government Area of Kaduna State, Nigeria.

The specific objectives are to:

1. Examine the difference in the achievement mean scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method.
2. Determine the difference in the retention mean scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method.

Research Questions

The following research questions guided the study:

1. What is the difference in the achievement mean scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method?
2. What is the difference in the retention mean scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method?

Hypotheses

The following null hypotheses were tested at the 0.05 level of significance:

H_o1: There is no significant difference between the post-test mean achievement scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method.

H_o2: There is no significant difference between the delayed post-test mean retention scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method.

Research Method

The study adopted a quasi-experimental research design, specifically the non-equivalent pre-test, post-test control group design. This design was considered appropriate because the study involved existing school classes that could not be randomly constituted into new groups. The population comprised 1,404 Junior Secondary Two students in 15 public junior secondary schools in Jaba Local Government Area of Kaduna State. The population consisted of 689 male and 715 female students. The sample comprised 181 JSS II students selected from two public junior secondary schools in the study area. The two selected schools provided the experimental and control groups. The experimental group received instruction through peer-to-peer learning strategy, while the control group was taught using the conventional lecture method.

Two instruments were used for data collection. These were the Basic Science and Technology Achievement Test (BSTAT) and the Basic Science and Technology Delayed Post-Test (BSTDP). The BSTAT consisted of 40 multiple-choice questions with four options each. The instrument was developed from relevant topics in the JSS II Basic Science and Technology curriculum, including materials and their uses, the human digestive system, drug abuse, elements, compounds and mixtures, and diseases. Each correct response attracted 2.5 marks, giving a maximum score of 100. The BSTDP was designed to assess students' retention of the concepts taught during the instructional period. It was administered to both experimental and control groups two weeks after the initial post-test. The delayed administration provided an opportunity to determine the extent to which students retained the knowledge acquired during instruction. The instruments were subjected to expert validation. Three experts from the Faculty of Education, University of Jos, assessed the suitability, clarity and content coverage of the test items. The Basic Science and Technology Achievement Test recorded a reliability coefficient of 0.849.

The treatment lasted six weeks. Students in the experimental group were organised into peer learning groups comprising four to six members. The groups included students with different academic abilities. More knowledgeable students served as peer tutors, assisting other members in understanding the concepts taught. The teacher supervised the activities, provided guidance and ensured that all students participated in the learning process. Students in the control group received instruction through the conventional lecture method. The same subject content was taught to both groups to ensure that differences in instructional strategies remained the major basis for comparison. The BSTAT was administered before the commencement of treatment to establish students' initial achievement levels. Following the six-week instructional period, the same achievement test was administered as a post-test. Two weeks after the post-test, the BSTDP was administered to determine students' retention levels. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was specified for testing the null hypotheses at the 0.05 level of significance. The pre-test scores were to be used as covariates to account for initial differences between the groups.

Results and Discussion

Research Question One

What is the difference in the achievement mean scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method?

Table 1: Pre-test and Post-test Achievement Mean Scores of Students Taught Using Peer-to-Peer Learning Strategy and Lecture Method

Group	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Gain
Experimental	21	36.90	6.94	62.29	21.77	25.38
Control	24	23.04	7.90	41.38	16.96	18.33
Mean difference in gain						**7.05**

The results in Table 1 show that students taught using peer-to-peer learning strategy (experimental group) recorded a higher post-test mean score of 62.29 compared with 41.38 recorded by students taught using the lecture method (control group). The experimental group also recorded a higher mean gain of 25.38 compared with 18.33 for the control group. The difference in mean gain was 7.05 in favour of the experimental group. This indicates that students exposed to peer-to-peer learning demonstrated greater improvement in academic achievement than those taught using the lecture method.

Research Question Two

What is the difference in the retention mean scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method?

Table 2: Delayed Post-test Mean Retention Scores of Students Taught Using Peer-to-Peer Learning Strategy and Lecture Method

Group	N	Mean	Standard Deviation	Mean Difference
Experimental	21	53.07	14.38	**22.95**
Control	24	30.13	14.24	
Difference		**22.95**		

The results in Table 2 show that students taught using peer-to-peer learning strategy recorded a delayed post-test mean score of 53.07, while those taught using the lecture method recorded a mean score of 30.13. The difference between the two groups was 22.95 in favour of the experimental group. This indicates that students exposed to peer-to-peer learning retained more of the knowledge acquired during instruction than students taught using the lecture method.

Hypothesis One

There is no significant difference between the post-test mean achievement scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method.

Table 3: ANCOVA Results on Achievement Mean Scores of Students Taught Using Peer-to-Peer Learning Strategy and Lecture Method

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2288.679	2	1144.340	2.991	.061
Intercept	5618.339	1	5618.339	14.687	.000

Source	Sum of Squares	df	Mean Square	F	Sig.
Pre-test	21.690	1	21.690	0.057	.813
Group	2266.989	1	2266.989	5.926	**.019**
Error	16066.220	42	382.529		
Total	138643.000	45			

R^2 = .234; Adjusted R^2 = .198.

The ANCOVA results in Table 3 indicate that there was a statistically significant difference in the achievement mean scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method. The group effect produced an F-value of 5.926 with a significance probability of .019, which is less than the 0.05 level of significance. Therefore, the null hypothesis was rejected. This indicates that the instructional strategy had a statistically significant effect on students' achievement, in favour of the peer-to-peer learning group. The partial eta squared was .124, indicating a moderate effect size.

Hypothesis Two

There is no significant difference between the delayed post-test mean retention scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method.

Table 4: ANCOVA Results on Retention Mean Scores of Students Taught Using Peer-to-Peer Learning Strategy and Lecture Method

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2133.685	2	1066.843	5.668	.007
Intercept	1515.576	1	1515.576	8.052	.007
Pre-test	895.828	1	895.828	4.760	.035
Group	1237.858	1	1237.858	6.577	**.014**
Error	7904.940	42	188.213		
Total	88608.000	45			

R^2 = .462; Adjusted R^2 = .437.

The ANCOVA results in Table 4 indicate that there was a statistically significant difference in the retention mean scores of JSS II students taught Basic Science and Technology using peer-to-peer learning strategy and those taught using the lecture method. The group effect produced an F-value of 6.577 with a significance probability of .014, which is less than the 0.05 level of significance. Consequently, the null hypothesis was rejected. This finding indicates that the instructional

strategy had a statistically significant effect on students' retention, in favour of the peer-to-peer learning group. The partial eta squared was .135, indicating a moderate effect size.

Summary of Findings

The findings revealed that students taught Basic Science and Technology using peer-to-peer learning strategy recorded higher achievement mean scores (62.29) than those taught using the lecture method (41.38). The ANCOVA result further established that the difference was statistically significant ($F = 5.926$, $p = .019$). This indicates that peer-to-peer learning strategy was more effective in improving students' achievement than the conventional lecture method. This finding supports the study by Ozoji, Salihu, Chollom and Dung (2022), who reported that peer-to-peer teaching strategy significantly improved students' achievement in Basic Science and Technology. Similarly, Animola and Bello (2019) found that students exposed to peer-to-peer learning strategy achieved better academic outcomes than those taught using alternative instructional approaches. Aku and Agu (2020) also reported that peer collaboration improved students' achievement in Basic Science and Technology. The consistency of these findings suggests that structured interaction and knowledge sharing among learners contribute positively to academic achievement. The finding is also consistent with Vygotsky's (1978) Social Constructivist Theory, which emphasises the importance of social interaction and guided learning in cognitive development. Through peer-to-peer learning, students have opportunities to explain concepts, exchange ideas and receive assistance from more knowledgeable classmates. These interactions may improve their understanding of scientific concepts and their ability to apply acquired knowledge. The higher achievement recorded by the experimental group therefore suggests that providing students with opportunities for active participation and collaborative learning can improve academic outcomes in Basic Science and Technology.

The findings also revealed that students taught Basic Science and Technology using peer-to-peer learning strategy recorded a higher delayed post-test mean score (53.07) than those taught using the lecture method (30.13). The difference of 22.95 was in favour of the experimental group. Furthermore, the ANCOVA result showed that the difference was statistically significant ($F = 6.577$, $p = .014$). This indicates that students exposed to peer-to-peer learning retained more of the knowledge acquired during instruction than those taught using the lecture method. This finding agrees with Animola and Bello (2019), who reported that students taught using peer-to-peer learning strategy demonstrated better retention of Basic Science concepts than those exposed to alternative instructional approaches. Similarly, Ashlame and Iwanger (2019) found that students exposed to peer tutoring recorded higher retention levels than those taught through conventional instructional methods. Agu and Samuel (2019) also reported that peer-assisted learning enhanced students' retention of Basic Science concepts through questioning, explanation and interaction among learners. The finding can further be explained by Ebbinghaus' (1885) Forgetting Curve Theory, which establishes that information may be forgotten over time when it is not adequately reinforced. Peer-to-peer learning provides opportunities for students to revisit concepts through repeated explanations, discussions and collaborative activities. These learning experiences may reinforce understanding and support the recall of previously acquired knowledge. The result also supports Vygotsky's (1978) Social Constructivist Theory, which recognises the contribution of social interaction to knowledge development. Therefore, the higher retention scores recorded by the experimental group suggest that peer-to-peer learning provides opportunities for reinforcing scientific knowledge beyond the immediate teaching process.

Conclusion

The study established that peer-to-peer learning strategy significantly improved students' achievement and retention in Basic Science and Technology compared with the conventional lecture method. Students exposed to peer-to-peer learning recorded higher achievement and delayed post-test mean scores than those taught using the lecture method. The findings suggest that structured peer interaction, knowledge sharing and collaborative learning can improve students' understanding and retention of scientific concepts. Therefore, peer-to-peer learning is an effective instructional strategy for improving learning outcomes in Basic Science and Technology at the junior secondary school level.

Recommendations

Based on the findings, the study recommends that:

1. Basic Science and Technology teachers should adopt peer-to-peer learning strategies to improve students' academic achievement and retention.
2. School administrators should organise professional development programmes to equip teachers with the skills required to implement peer-to-peer learning effectively.
3. Curriculum planners should encourage the integration of collaborative learning activities into Basic Science and Technology instruction.
4. Teachers should organise students into mixed-ability groups to encourage knowledge sharing and active participation.

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