International Journal of Multidisciplinary Research and Growth Evaluation.

Effectiveness of Collaborative-Based Learning on the Achievement of Students in Basic Science at Junior Secondary Schools in Kebbi State, Nigeria

Abubakar Abubakar
Adamu Augie College of Education, Argungu, Kebbi State Nigeria

* Corresponding Author: **Abubakar Abubakar**

Article Info

ISSN (Online): 2582-7138
Impact Factor (RSIF): 7.98
Volume: 06
Issue: 06
November - December 2025
Received: 12-09-2025
Accepted: 16-10-2025
Published: 14-11-2025
Page No: 349-353

Abstract
There is a need for a change from teacher-centered approaches to more learner-centered methods that are designed to improve learners' engagement and learning involvement. The current study compared Collaborative Learning Method (CLM) with Traditional Learning Method (TLM) to determine its effectiveness on student's achievement in the states of matter in Basic Science subject. Quasi-experimental non-equivalent control groups research design was employed. Purposive sampling was used in composing two intact classes. There was a sample of 63 students distributed across experimental (31) and control (32) groups in two public secondary schools located in Kebbi, Nigeria. Descriptive statistics and the sample t-test were used to examine the variables. Data for this study were generated through pre-test, post-test, and delayed post-test. The results revealed a significant difference in the student's achievement in states of matter favoring the experimental group who experienced CLM with a large effect size. However, there is no striking effect among students who experienced CLM environment on retention of achievement.

Keywords: Collaborative Learning, Traditional Learning Method, Achievement, Retention

1. Introduction

Scientific and technological progress of any nation globally depends on science education. Nigeria being a developing country is aware of the critical roles science education played in the economic and social growth of a nation (Akpokiniovo & Odebala, 2015) [1]. The Nigerian government adopted basic science and technology as compulsory courses for the basic educational level to provide a strong foundation for science and technology (Ozoji, 2020) [25]. The basic science is taught such that the child acquires the conception of the fundamental unity of science, the standard approach to scientific nature, and the importance and function of science in daily life and the world (FRN, 2013) [12]. Hence, in its National Policy on Education document recommended the adoption of child-centered approach in teaching and learning of science (Federal Republic of Nigeria, 2013) [12]. Despite the government's efforts to promote science teaching and learning among students at basic educational levels, the number of students enrolled in core science subjects and science-oriented courses at the senior secondary school level and tertiary institutions is low. State of matter is among the foundational topics of basic science under sub-theme of "You and Energy" which require students to understand the assumptions of the kinetic theory of matter, the molecular structure of solids, liquids and gasses using kinetic theory of matter, distinguish between evaporation, melting, freezing, and boiling as captured in Nigerian Junior secondary school science syllabus (FRN, 2013) [12]. These concepts were perceived difficult and misconceived by majority of students.

Among the biggest challenges of basic science teaching and learning in Nigeria is the method of teaching used by the teachers (Omorogbe, 2013) [21]. As lamented by Obianuju, (2013), inappropriate approaches of instruction have contributed greatly to the difficulties. Onwu and Randall (2006) hold that atom and molecular structures' concepts are challenging for students to understand [22]. Alamina and Etokeren (2018) argue that students develop different misconceptions due to the abstract nature of the science concepts [2]. In light of this, more research is needed to determine effective instruction suitable for science teachers and students.

Objectives of the Study

1. To examine the effectiveness of CLM and TLM on the achievement of Junior Secodary School Two (JSS II) students in the states of matter.
2. To determine the effectiveness of CLIM and TLM on the retention of JSS II students in the states of matter.

Research Questions

1. Is there any difference between the effect of CLM and TLM on JSS II students' achievement on states of matter?
2. Is there any difference between the effect CLM and TLM on the retention of JSS II student in states of matter?

Research Hypothesis

1. There is no significant difference between the Scores of Post Test and Delayed Post Test of Students exposed to Collaborative Learning Method.

Review of Related Literature

Basic Science Education in Nigeria

According to Chalmers (2013), science is a structured framework of knowledge and complex activity that leads to the universal body of knowledge called laws, hypotheses, and theories explaining the natural prodigies. It is a subject that has an impact on our everyday activities. On the other hand, Wasagu (2009) described science education as an integral area of study that addresses science disciplines, i.e. (biology, chemistry, and physics) and the process followed in science teaching and learning [29]. Subsequently, science teachers' roles are to guide individuals to discover how facts are known and how these facts can be built from fragments of data into a structural form of knowledge.

In Nigeria today, the junior secondary level of education is both academic and pre-vocational. It is now compulsory in all the federation; the aim is for all citizens to have access to basic education (FRN, 2013) [12]. Basic science is one of the compulsory subjects for junior secondary education. Basic science teaching is integrated, comprising biology, chemistry, and physics topics (Bukunola & Idowu, 2012) [7]. This ensures individuals acquire scientific knowledge and develop scientific skills. The role of science in the development of a nation can never be emphasized. It is needless to argue that active student engagements in the process of learning science are the key to knowledge acquisition

In recognition of the critical role of science for national development, the Federal Government of Nigeria in the National Policy on Education gave a special place to science, technology, and mathematics education and the promotion of scientific literacy to her citizenry (FGN, 2013). According to the Science Teachers Association of Nigeria (1970), basic science should enable students to be able to: carefully and thoroughly observe, report entirely and accurately, organize data gathered, make a generalization based on acquired data, raise hypotheses, design experiments, use models to clarify phenomena and proceed the process of inquiring when new information does not conform to predictions. These objectives can only be acquired if the teaching of basic science involves collaborative or team work, inquiry, discovery teaching tactics, problem solving activities, and open-ended field of laboratory exercises.

Misconceptions on States of Matter among Basic Science Students

Tatar (2011) [28] opined that, although the states of matter are regarded as a simple and well-known topic, there is an increasing number of student and teacher's misconceptions on the change of states. He further lamented, since "States of matter" is an important subject that concerns our daily lives, a lacks of complete ideas about the concepts may have a detrimental effect on the scientific understanding of the other concepts in the subsequent learning of science. Furthermore, Tatar (2011) [28] suggested that more studies on reducing or eliminating such misconceptions should be conducted. Laliyo, Tangio, Sumintono, Jahja, and Panigoro (2020) [17] also argued that more studies should be conducted because studies have found students' misconceptions of matter somewhat resistant.

Hanson, (2020) [15] argued that because of lingering misconceptions students hold, coupled with the low academic achievement which invariably leads to loss of interest in studying science, teachers should select and adopt an instructional approach that looks into prior information of students, provides hands and mind on activities and support science teachers in the dissemination of knowledge through inquiry activities. Taber (2002) and Aydin, Aydemir, Boz, Cetin-Dindar, and Bektas (2009) also support Hanson's assertion on the need for an innovative approach.

Among the most common misconception individual have is the belief that gas is not a substance and has no weight or mass. Students also hold alternative conceptions regarding the bubbles that rise from boiling water (Treagust *et al*., 2010). A study conducted by Griffiths and Preston (1992) reports that almost 50% of 18-year students think water molecules in steam are more extensive than those in ice. Many students state that the bubbles rising in boiling water are hydrogen gas and oxygen gas (Harrison & Treagust, 2002; Othman *et al*., 2008). Students believe that when a substance expands or contracts, such as water expanding when it freezes to form ice, the volume of the individual molecules changes instead of the space between them (Yezierski & Birk, 2006). Students' inability to comprehend electrostatic forces between particles leads to misconceptions involving the relationships between the states of matter of a single substance. Studies have shown that students believe that matter is continuous and smooth in the solid-state based on their macroscopic observations (Pozo & Gomez Crespo, 2005; Talanquer, 2009).

Methodology

Quasi-experimental design was employed because it was not feasible to randomly assign a subject to treatment groups (Creswell, 2012; Emmanuel, 2013). Specifically, this study utilized a non-equivalent control and experimental group, pre-test, post-test, and delayed post-test design to investigate the effect of independent variables on the dependent variable. State of Matter Achievement Test (SMAT) was developed by the researcher to gather data from pre, post, and delayed posttest. A five-day workshop was organized by the researcher for research assistants on how to implement the current approach.

A pretest was conducted to find out the knowledge level of students on the state of matter concept. This was followed by intervention which lasted for eight weeks. immediately after

the intervention, post test was conducted. Two weeks later a delayed post test was conducted to find out the retention level of the students.

Two public secondary schools were selected randomly in which purposive sampling was employed in assigning participants into intact classes of experimental and control group. The 80 sample of JSSII students were divided into two groups. The first experimental group (n=40) received instruction using the CLM, whereas the second group i.e. the control group (n=40) received support using a TLM. Finally, for data analysis, IBM SPSS version 26 was used. Descriptive statistical techniques were employed to find the mean and standard deviation for the pre-tests, post-tests and delayed posttest of the SMAT. To test the hypothesis an independent samples t-test was used.

Results

Table 1: Mean Scores of Students on SMAT for Pre-Test and Post-Test

Group	N	Pre-test		Post-test		Mean difference
		Mean	Std. Dev.	Mean	Std. Dev.	
Control	40	9.50	4.624	10.63	4.705	1.13
Experimental	40	10.25	4.960	16.90	3.470	6.65
Mean difference		0.75		6.27		

The two groups had no major difference in their achievement before the intervention as shown in Table 1. The mean difference was 0.75. After the intervention in which the experimental group were taught with the collaborative learning method, the mean difference rose to 6.27. The mean score of students in the control group did not differ much between the pre-test and post-test. The mean difference was 1.13. The mean score of students in the experimental group increased from 10.25 to 16.9 with a mean difference of 6.65. Use of the collaborative learning had a major positive effect on the achievement of students.

Table 2: Mean Scores of Students on SMAT for Post-Test and Delayed Post Test

Group	N	Post-score means		Delay score Means		Mean difference
		Mean	Std. Dev.	Mean	Std. Dev.	
Control	40	10.63	4.705	13.18	5.144	2.55
Experimental	40	16.90	3.470	16.80	3.065	0.10
Mean difference		6.27		3.62		

The students in the control group had a lower mean retention score on the state of matter achievement test compared with their counterpart the experimental group. The control group had a mean achievement of 10.63 compared with the experimental group with a mean score of 16.90. The mean difference was 6.27. At the delayed test (retention) test level the mean achievement of the control group rose to 13.18 with a standard deviation of 5.144 and increased mean difference of 2.55. For the experimental group, mean achievement was 16.80 with a standard deviation of 3.065. The mean difference was 0.10. At the retention test level, the improvement in State of matter achievement test by students in the experimental group did not reduce much which showed that the application of collaborative learning had positive effect on retention of achievement in the state of matter concept in Basic Science.

Table 3: Two Sample T-Test on Post and Delay Post-Test of SMAT for Students Exposed to collaborative Learning

Stage	N	Mean	Std. Dev.	Std. Error	t-value	df	p-value
Post-test	40	16.90	3.470	0.549	0.064	78	0.942
Delayed-test	40	16.80	3.065	0.485			

(t-critical =2.00, $p < 0.05$)

Result in Table 3 revealed that mean post-test achievement of the students exposed to the use of the CLM did not differ significantly from the mean score at the delayed post-test level. The observed t-value was 0.064 with a p-value of 0.942 ($p > 0.05$). These observations did not provide sufficient evidence for rejecting the hypothesis. The hypothesis that there is no significant difference between the Scores of Post Test and Delayed Post Test of Students exposed to Collaborative Learning Method is therefore retained.

Discussion

The findings of this study revealed that use of collaborative learning significantly improved mean achievement of students in learning state of matter when compared with students in the traditional method of instruction. The study found that performance of the students was significantly higher after the intervention than was obtained before the intervention. The observed difference was found to be significant. The finding here is in line with Bukunola, & Idowu, (2012) [7]; Bimbola, & Daniel, (2010) [5] who reported that collaborative learning is capable of engaging in hands-on activities which enhance students to obtain high performance and develop scientific skills.

As showed in table 1, the two groups (experimental and control) had no major difference in their achievement before the intervention. The mean difference was 0.75. According to Table 2, after the intervention, the results of the post-test on students' performance in Basic science shows that students who received instruction using the CLM had higher mean scores (Mean =16.90) than students who received treatment using Traditional Method, with lower mean scores (Mean = 10.63). This finding is consistent with Gezim & Xhomar, (2020); Fitriani, *et al*., (2020) [13], and Sunyoung, *et al*., (2016) [27] findings that students perform better academically

when taught utilizing the CLM than those taught with traditional methods of instruction. The study's findings were actually supported by the report of Atusumbe, (2019) [3]; Bahar, *et al*., (2020) [4]; and Blancia and Fetalvero (2021), which stated that CLM is an effective technique for promoting students' inquiry skills, which motivates them to explain scientifically discrepant events.

The result supports the research by Bukunola, & Idowu, (2012) [7] and Fitriani, *et al*., (2020) [13], who looked at the impact of the CLM techniques on secondary school students' performance in science. Their findings demonstrated that the CLM group outperformed the traditional teaching method group by a large margin. Additionally, the present study is in line with Blancia & Fetalvero, (2021), who reported that when science concepts were taught via the CLM, students have positive understanding and performed better. When compared to conventional methods of instruction, the study found that students in the CLM class had a better conceptual knowledge of the concepts of diffusion and osmosis.

The results of a post-test support Fitriani *et al*., (2020) [13] and Bukunola, & Idowu, (2012) [7], claim that CLM have a good impact on students' knowledge and skills acquisition and Aidoo, Boateng, Kissi & Ofori, (2016) who maintained that CLM is a powerful method for enhancing learning. Arifin, *et al*., (2021) also asserted that, as compared to conventional teaching methods, CLM improve students' potential for retention. Mean post-test achievement of the students exposed to use of the collaborative method did not differ significantly from the mean score at the delayed post-test level. The observed t-value was 0.064 with a p-value of 0.942 ($p > 0.05$). This was an indication that, students taught with CLM can retained information learned and can produce it any time needed.

The study therefore is in support of Atusumbe (2019) [3], who stated that compared to conventional methods of instruction, the student-centred approach boost student's performance and retentive capacity. The present study is also in line with the findings of Ameen, *et al*., (2022) who claimed that utilizing CLM in classroom instructions helps students to retain information and perform better in their examinations. Conventional methods of instruction have been found by this study to have negative effect in learning basic science. This supported the findings of Samsudin *et al*., (2020) [26], Gorowara & Lynch, (2019) [14] that effective learning is minimal via traditional styles of instruction.

Similar results from the post-test (Mean = 16.90) and delayed post-test showed that students who were taught Basic Science using the CLM retained more information (Mean = 16.80). This could be due to active participation and hands on activities. The finding here is in line with Bicer *et al*., (2015) who reported that collaborative learning is capable of engaging in hands-on activities which enhance students to recall and obtain high performance. The null hypothesis, which claimed that there is no significance difference in the mean achievement of post-test and delayed post-test of students taught state of matter concept using CLM has been retained. The difference between the two test scores was statistically insignificant when the findings were subjected to two sample t-test analysis ($p > 0.05$). Thus, the CLM enhances student retention in Biology in government-owned secondary schools by having a beneficial effect.

The majority of students were found to comprehend the concepts of state of matter correctly in the collaborative learning environment which mostly consisted of practical activities and decision-making. Students were able to grasp the concepts of state of matter and to clarify their misconceptions that had developed before their engagement to the new approach. This study is in conformity with the findings of Sakir & Kim, (2020), that CLM is the strategy which encourages practical activities, increases learning activities and allowed decision-making as well as offering suggestions and feedback to aid in learning.

Conclusion and Implications

The primary motivation for educators to seek out more effective pedagogical strategies is to improve student achievement. Based on the results of using the collaborative technique to assess students' Basic Science achievement, it can be concluded that the approach greatly outperforms the conventional teacher-centred method in terms of student achievement. The application of CLM would be an effective learning technique that may be utilized to help students overcome conceptualization or misconceptions issues. This would undoubtedly address the long-standing issue of low success caused by student incapacity to recollect facts during examinations.

The current research has a wide range of implications for students, teachers, curriculum planners, states and federal ministry of education and educators. The results indicated that providing equity in classroom ensure equality of outcome across students irrespective of their learning difference. There is evidence that teaching a content course using instructional material prepared based on collaborative learning can support students to learn actively and improve students' learning, as a result, increases students' achievement. Therefore, the study has provided a better understanding of the constructivism school of thought on instruction.

Teachers need to consider and determine student's possible misconceptions before teaching delivery so as to promote concrete and meaningful learning and to avoid the building up more misconceptions. In addition, teachers need to be mindful of the difficulties faced by students when learning the concepts. Teachers should be aware that students need only guidance by providing them with all the necessary materials and procedures to construct their own knowledge. Teachers should therefore use appropriate materials in teaching, guide students by providing procedures in the conduct of any scientific experimentation.

References

1. Akpokiniovo SR, Odebala E. Implementing the universal basic science education curriculum for development in Nigeria beyond 2020. Multi-Disciplinary J Acad Excell. 2015;13(1):56-67.
2. Alamina JI, Etokeren IS. Effectiveness of imagination stretch teaching strategy in correcting misconceptions of students about particulate nature of matter. J Educ Soc Behav Sci. 2018;27(1):1-11.
3. Atsumbe BN. Refocusing science, technology, engineering and mathematics (STEM) education in Nigeria for societal needs. Kontagora J Sci Technol. 2019;4(1):1-12.
4. Bahar M, Aksut P. Investigation on the effects of activity-based science teaching practices in the acquisition of problem-solving skills for 5–6-year-old pre-school children. J Turk Sci Educ. 2020;17(1):22-39.
5. Bimbola O, Daniel OI. Effect of constructivist-based

teaching strategy on academic performance of students in integrated science at the junior secondary school level. Educ Res Rev. 2010;5(7):347-53.
6. Blyth K. Effectiveness of using inquiry based instruction to increase students' performance in high school biology [master's project]. Norfolk (VA): Old Dominion University; 2010. Available from: http://digitalcommons.odu.edu/cgi/viewcontent.cgi?article=1045&context=ots_masters_projects
7. Bukunola BAJ, Idowu OD. Effectiveness of cooperative learning strategies on Nigerian junior secondary students' academic achievement in basic science. J Educ Soc Behav Sci. 2012;2(3):307-25.
8. Campbell DT, Riecken H. Quasi-experimental design. In: Sills DL, editor. International encyclopedia of the social sciences. Vol. 5. New York: Macmillan; 1968. p. 259-63.
9. Chalmers AF. What is this thing called science? 4th ed. Indianapolis (IN): Hackett Publishing; 2013.
10. Creswell JW. Research design: qualitative and quantitative approaches. Thousand Oaks (CA): Sage; 1994.
11. Creswell JW. A concise introduction to mixed methods research. Thousand Oaks (CA): SAGE Publications; 2014.
12. Federal Republic of Nigeria. National policy on education. 6th ed. Lagos: NERDC Press; 2013.
13. Fitriani A, Zubaidah S, Susilo H, Al Muhdhar MHI. The effects of integrated problem-based learning, predict, observe, explain on problem-solving skills and self-efficacy. Eurasian J Educ Res. 2020;85:45-64.
14. Gorowara S, Lynch R. A comparative study of grade 6 science students' academic achievement under teacher-centered learning method and inquiry-based learning method at Panchasap. Human Sci. 2019;11(2):153-64.
15. Hanson R. Chemistry teachers' interpretation of some students' alternative conceptions – a pilot study. Afr J Chem Educ. 2020;10(1):6996.
16. Idowu D. Developing Nigerian integrated science curriculum. Int J Sci Technol Educ Res. 2011;2(8):134-45.
17. Laliyo LAR, Tangio JS, Sumintono B, Jahja M, Panigoro C. Analytic approach of response pattern of diagnostic test items in evaluating students' conceptual understanding of characteristics of particle of matter. J Balt Sci Educ. 2020;19(5):824-33.
18. Nigerian Educational Research and Development Council (NERDC). National policy on education. 6th ed. Lagos: NERDC; 2013.
19. Obianuju OS, Obiajulu AN, Ella FA. Science education for sustainable development in Nigeria: challenges and prospects. Acad J Interdiscip Stud. 2013;2(6):159.
20. Okoro SU. Basic science education and development: a virile vehicle for education and development in Nigeria beyond 2020. J Pristine. 2015;11(1):206-16.
21. Omorogbe E, Ewansiha JC. The challenge of effective science teaching in Nigerian secondary schools. Acad J Interdiscip Stud. 2013;2(7):181-96.
22. Onwu GO, Randall E. Some aspects of students' understanding of a representational model of the particulate nature of matter in chemistry in three different countries. Chem Educ Res Pract. 2006;7(4):226-39.
23. Osuyi SO. Effect of problem-based teaching method on students' academic performance in basic technology in university demonstration secondary schools, Edo State, Nigeria. Sokoto Educ Rev. 2021;20(1&2):75-85.
24. Othman J, Treagust DF, Chandrasegaran A. An investigation into the relationship between students' conceptions of the particulate nature of matter and their understanding of chemical bonding. Int J Sci Educ. 2008;30(11):1531-50.
25. Ozoji BE. Effects of concept mapping technique on Nigerian junior secondary school students' cognitive development and achievement in basic science and technology (integrated science). In: Science education in the 21st century. New York: Springer; 2020. p. 95-111.
26. Samsudin MA, Jamali SM, Md Zain AN, Ale Ebrahim N. The effect of STEM project-based learning on self-efficacy among high-school physics students. J Turk Sci Educ. 2020;16(1):94-108.
27. Sunyoung Han A, Rosli R, Capraro MM, Capraro RM. The effect of science, technology, engineering and mathematics (STEM) project-based learning (PBL) on students' achievement in four mathematics topics. J Turk Sci Educ. 2016;13(Special Issue):3-27.
28. Tatar E. Prospective primary school teachers' misconceptions about states of matter. Educ Res Rev. 2011;6(2):197-200.
29. Wasagu MA. Rethinking science education for the changing times: the writing on the wall. Nigeria: Trans-akab LTD; 2009.

How to Cite This Article
Abubakar A. Effectiveness of Collaborative-Based Learning on the Achievement of Students in Basic Science at Junior Secondary Schools in Kebbi State, Nigeria. Int J Multidiscip Res Growth Eval. 2025;6(6):349-353.