

Effect of Active Learning Approach on Senior Secondary Students' Chemistry Performance in Rivers State, Nigeria

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Abstract

This paper examined the effect of active learning approach on Senior Secondary School Students' Chemistry Performance in Rivers State. Quasi-experimental, non-equivalent pre-test, post-test control group design was adopted for the research. A sample size of fifty (50) senior secondary school II students participated in the study. Two research questions and two null hypotheses guided the study. A validated instrument titled Chemistry Performance Test (CPT) was used to collate the data. The reliability of the instrument was established using Kuder-Richardson -21 (KR-21) to obtain an index of +0.84. The research questions were answered using mean and standard deviation while the hypotheses were tested using ANCOVA at 0.05 significant level. Findings from the study revealed that the Chemistry students taught using active learning approach made higher learning performance gain than those taught with the traditional lecture method. There was a significant effect of the use of active learning approach over the traditional lecture method on the scores of the students. It was recommended among others that the use of active learning approach be adopted as a learning approach in the teaching and learning of Chemistry at all levels of education to enhance learning and improve students' performance in Chemistry.

Keywords: active learning approach, secondary school students, chemistry performance

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Introduction

Science is a branch of knowledge that studies matter and the environment. It is the very cornerstone on which anchors the modern-day technological advancement. Chemistry is one of the core science subjects studied in both secondary school and higher institutions. It is a central science that permeates all our lives. Chemistry as a science subject makes use of specific terms to define relationships and changes that occur in real life situations (Macrothink Insitute, 2023). It is the branch of science that deals with the properties, composition, and structure of elements and compounds, how they undergo changes from one state to another, and the energy that is released or absorbed when they change (Ugonwa et al., 2024). It is a science within the natural sciences that studies the chemical elements that make up matter and compounds made of atoms, molecules, and ions, their composition, structure, properties, behavior, and the changes they undergo when they react with other substances. Chemistry also addresses the nature of chemical bonds in different chemical compounds and studying chemistry as a subject is important because everything, we do is chemistry. Everything in our life is based on chemistry. Even the human body is made of chemicals. Chemistry is therefore a big part of our everyday life. The importance of this branch of science can be seen in different spheres of human life such as in the food we eat, the air we breathe, various cleansing agents, toothpastes, lotions, facewash, pharmaceuticals, batteries in watches, mobile phones, cars, laptops, and other electronic devices, and fuel in our vehicles to mention but few as instances of chemistry in our daily lives, thus, all matter is made of chemicals, therefore chemistry is the study of everything.

Learning Chemistry enable students to learn about the scientific method and gain skills in critical thinking, deductive reasoning, problem-solving, and communication. Obafemi and Ugonwa (2025) opined that teaching of chemistry to students at a young age can increase student interest in STEM careers. Some concepts to study in chemistry include, Atomic structure, the Periodic table, Chemical bonding, Chemical reactions and Stoichiometry, Acids and bases, Electrochemistry and Organic chemistry. Chemistry can help us to understand, monitor, protect and improve the environment around us. Over the years, Chemists have developed tools and techniques which ensure that we can see and measure air and water pollution. They have helped to build the evidence that shows how our climate has changed over time. In a nutshell, Chemistry helps us understand the world around us and improve the quality of life while ensuring safety. In addition, a good understanding of chemistry will help us solve many future problems, including sustainable energy and food production, managing our environment, providing safe drinking water, and promoting human and environmental health. Dike and Ugonwa (2021) opined that chemistry is an integral part of other science subjects and requires both theory and practical learning. Chemistry plays a vital role on students understanding of science and expertise in scientific advancement. Practical and experiential learning has been known to enhance motivation to learning chemistry and enable students develop science process skills which helps them to deal with abstract knowledge (Macrothink Insitute, 2023).

Experiential learning is a direct experience -based learning approach which may involve hands-on learning. Students in this approach learn by actively participating in the real-world activities, experiments, or projects. Active learning is an experiential learning approach in which learners play active role in the learning process, making decisions and solving problems (Nwanekezi & Ugonwa, 2021). It is the approach to learning that involves students actively engaging in the learning experiences rather than passively receiving information. Active learning approach

engages students into critical thinking, problem solving and ability to apply what they have learnt. The major characteristics of active learning are:

- ✓ It is student - centered. Active learning focuses on the learning process of the students rather than the teachers transmission of information.
- ✓ It involves hands-on activities. Active learning incorporates activities that require students to manipulate, experiment or innovate.
- ✓ It encourages students collaboration as the students share ideas and learn from each other.
- ✓ It enables critical thinking since the students are required to think, analyze evaluate and synthesize information.
- ✓ It encourages problem solving, where students are engaged in identifying and solving real-world problems.
- ✓ Active learning approach encourages students to reflect on their learning experiences, share and receive feedback from peers and instructors.

Active learning gives the learners direct experience as they engage in practical experiences rather than just reading or listening to the teacher. The strategies for active learning approach include:

- ❖ Discussions and Debates
- ❖ Group projects and presentations
- ❖ Experiments and role-playing
- ❖ Problem-based learning
- ❖ Think-pair share and peer instruction

According to Nwanekezi et al. (2023), to apply active learning approach in the classroom, the teacher selects a topic and a student, allows the students to think about the topic and list out all he knows about the topic. He is then paired with someone in the class where they compare their lists thereby exchanging ideas. Later the class is grouped into four or five where there is further exchange of ideas after which the groups come up with a list of contributed ideas as feedback to be discussed in the classroom.

Wolf et al. (2015) in their study highlighted the Matrix of active learning techniques to include: Think-pair-share, Concept maps, Role play, Jigsaw, Team-based learning, problem-based learning, Thinking Hats and more. They submitted that active learning helps to increase retention in students and facilitate transfer of knowledge. They also added that when learners are actively involved in their learning, knowledge will be transmitted, and they will effectively apply their knowledge and skills. A brief description of how some of these techniques can be applied in the classroom is discussed as follows:

Think-Pair-Share – Here the teacher pose a question to the group and allow the learners to consider their response individually. Then, he instructs the learners to pair with a neighbor to compare responses and come up with feedback. He concludes by randomly calling on pairs to share with the entire class.

Concept maps – This technique involves forming a mental picture of relationships between concepts diagrammatically. It Can be done individually or in groups where the students will use a cardboard paper to draw or do a schematic representation of the concept.

Jigsaw – In this technique, the teacher divides the topic into several smaller, interrelated pieces and assigns each member of the team a part of the topic to read and master it. With this, each

of them is asked to teach their team members about their own piece. When each person in the group has finished teaching their own part, the puzzle is collated by the teacher to conclude the lesson.

Team-based learning - Here the teacher forms Small-groups of between four and ten members who will learn a concept together before the class session. After this, during the classroom session, the learners are tested on the preclass material they learnt and then challenged to explain the core content or model the concept learnt as a team.

Role play – Here learners are given a particular role to act or a particular viewpoint to better understand the concepts and theories in question.

Some of the benefits of active learning approach are:

1. Increases engagement and motivation in the students.
2. Promotes deep understanding and retention in the learners.
3. Students develop critical thinking and problem-solving skills.
4. It enhances collaboration and communication skills in the students.
5. It improves student autonomy and self-directed learning.

By using active learning approach in the teaching and learning of chemistry as a subject, there would be effective interaction and participation of every student in the class and this will bring collaboration and critical thinking among them. The role of the teacher here is to create engaging and conducive learning environment, then ensure adequate and even grouping of the students having both the brilliant and the weak students together in every group. The review of Nguyen et al. (2021), on Instructor strategies to aid implementation of active learning, submitted that the use of active learning in STEM fields has been linked to improving students learning and retention, particularly among students from some underrepresented groups.

Camacho and Legare (2015) conducted a study on opportunities to create active learning in the classroom and submitted their findings that incorporating active learning methods into the classroom will enable instructors to create opportunities for learning instead of allowing students to sit passively and learn by absorbing information passed by the instructor.

Kim et al. in Camacho and Legare (2015) described the benefits of active learning techniques to include, improved critical thinking skills, increased motivation, and enhanced interpersonal communication skills.

Galbraith and Fouch (2007), in their study, established that active learning techniques enable students to organize and reflect; practices that reinforce learning.

The traditional lecture or “talk and chalk” method of teaching and learning have been observed to be ineffective in promoting deep understanding of concepts, critical thinking, and problem-solving skills in chemistry students. The passive reception of information leads to poor retention, lack of participation and inability to apply knowledge in real-world situations. Wolf et al. (2015), established from their findings that most teachers rely on the traditional lecture method of teaching which unfortunately only permits learners to retain little or no knowledge of what they are taught in the class, and they rarely apply what they learn. Moreso, the rapidly changing trends of the 21st century require that students be equipped with skills such as collaboration, creativity, and adaptability, which are not common with the traditional teaching methods. A shift toward an active learning approach that empowers students to take ownership

of their learning and engages them in participatory learning experiences may likely improve the academic performance of the chemistry students and help them to develop the skills and competencies necessary for success in an evolving world. Active learning approach provides students with rewarding and joyful learning experiences unlike the traditional passive talk and chalk method of learning. It is therefore expedient to examine the effect of active learning approach on the performance on the chemistry students in the secondary schools in Rivers State.

Aim and Objectives of the Study

The aim of this study is to examine the effect of active learning approach on the performance of chemistry students in senior secondary schools in Rivers State. The specific objectives of the study are to;

1. Determine the mean performance score of chemistry students exposed to active learning approach and lecture method in secondary schools in Rivers State.
2. Examine the mean performance score of the male and female students in chemistry who were exposed to active learning strategy in the secondary schools.

Research Questions

The following research questions guided the study.

1. What is the mean performance score of the SS2 chemistry students who were taught using active learning approach and those taught using lecture method in secondary schools in Rivers State?
2. What is the mean performance score of male and female students in the secondary schools who were exposed to active learning strategy in chemistry?

Hypotheses

1. There is no significant difference in the mean performance score of the chemistry students exposed to active learning approach and that of those taught with lecture method in the secondary schools in Rivers State.
2. There is no significant difference between the mean performance score of male and female students in the secondary schools who were exposed to active learning strategy in chemistry?

Methodology

Quasi-experimental, non-equivalent pre-test, post-test control group design was used for the study. The area of the study was Port Harcourt City Local Government Area of Rivers State. The population of the study comprises of four hundred and twenty (420) senior secondary school two (SSS2) chemistry students in Port Harcourt City Local Government Area of Rivers State. Simple random sampling technique was used to select sample size of 50 SSS2 chemistry students from two intact classes of two schools: Model Girls Secondary School Rumueme and Community Secondary School Nkpolu Oroworukwo, Port Harcourt. The schools were selected using purposive sampling technique and assigned to experimental and control groups by balloting.

Table 1*Experimental Procedure*

	Groups	Pre-test	Treatment	Post-test
Experimental	1	Pre-test given on chemistry performance test.	Taught using active learning approach.	Post-test given on chemistry performance test.
Control	2	Pre-test given on chemistry performance test.	Taught using lecture method.	Post-test given on chemistry performance test.

The instrument used for data collection was chemistry performance test (CPT) which was developed by the researcher. The CPT instrument was constructed based on the topic “The Periodic Table” and used for pre-test and post-test. The CPT comprises of forty (40) multiple choice objective questions with options A, B, C and D having 2.5 marks assigned to each correct answer while wrong answers attract zero (0) score. 100 marks was the maximum score for the data. The CPT instrument was validated by one chemistry teacher and one measurement and evaluation expert. They ascertained the face, content, and construct validity of the instrument. The CPT instrument was also trial tested using 20 SSS2 chemistry students from another school of the same area of study. The reliability of the instrument was gotten using Kuder-Richardson-21 (KR-21) to calculate the data obtained from the CPT trial -test scores and a reliability co-efficient of 0.84 was obtained. The two sampled schools were grouped into experimental and control groups (Groups one and two, respectively). Group one were taught using Active learning approach (jigsaw, think-pair-share, concept mapping and Team-based learning were used), while Group 2 were taught using the conventional lecture method. Prior to the start of the lesson, the researcher explained the features of the Active learning approach to the students in the experimental group. The CPT instrument where then given to both the Experimental and Control groups and data collected and marked to obtain the pre-test scores of both groups. The researcher decided to administer the treatment and instrument by herself on different days of the schools since a schedule was drawn and agreed upon by the researcher and chemistry teachers with the permission of the school authority (based on the timetable). The treatment lasted for three weeks, after which a post-test was administered to both the Experimental and Control groups by the researcher. Data collected was also marked and scores recorded for analysis. Mean and standard deviation was used to answer the research questions while Analysis of Co-variance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results and Findings

Research question 1: What is the mean performance score of SSS2 chemistry students taught using Active learning approach and those taught using Lecture method in senior secondary schools in Rivers State?

Table 2

Mean, Standard Deviation and Mean Gain of Students' Performance Using Active Learning Approach and Lecture Method

Method	Pre-test			Post-test		Mean Gain
	N	\bar{x}	SD	\bar{x}	SD	
Active learning	50	30.10	6.03	76.70	12.12	46.60
Lecture Method	50	30.50	5.80	59.20	8.38	28.70

Table 2 showed that the students taught chemistry using active learning approach had a mean gain score of 46.60 while those taught chemistry using lecture method had a mean gain score of 28.70. This is an indication that students taught chemistry with active learning approach performed better than the students taught with lecture method.

Research question 2. What is the mean performance score of male and female students in the secondary schools who were exposed to active learning strategy in chemistry?

Table 3

Mean, Standard Deviation and Mean Gain of Male and Female Students in Chemistry Taught Using Active Learning Approach

Gender	Pre-test			Post-test		Mean Gain
	N	\bar{x}	SD	\bar{x}	SD	
Male	25	28.40	6.47	74.20	13.56	45.80
Female	25	31.40	5.27	82.60	8.91	51.20

Table 3 shows that the male students taught with active learning approach had a mean gain of 45.80 while the female students exposed to active learning approach had a mean gain score of 51.20. This is an indication that the female students taught chemistry using active learning strategy performed better than their male counterparts.

Hypothesis 1. There is no significant difference in the mean performance score of the chemistry students exposed to active learning approach in the secondary schools in Rivers State.

Table 4

ANCOVA Analysis of Students Taught Chemistry Using Active Learning Approach and Lecture Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	10415.645	2	5207.822	47.529	.000	.495
Intercept	16441.036	1	16441.036	150.050	.000	.607
Pre-test	11.645	1	11.645	.106	.745	.001
Methods	10307.198	1	10307.198	94.061	.000	.492
Error	10628.355	97	109.571			
Total	488900.000	100				
Corrected Total	21044.000	99				

Table 4 shows that the calculated F-ratio is 94.061 and significant at $p = 0.00$ ($p < 0.05$). The null hypothesis was rejected. This shows that there is significant difference between the mean performance score of students taught chemistry using active learning approach and those taught using lecture method in senior secondary schools in Rivers State.

Hypothesis 2. There is no significant difference between the mean performance score of male and female students in the secondary schools who were exposed to active learning strategy in chemistry?

Table 5*ANCOVA Analysis of Male and Female Students Taught Chemistry Using Active Learning Approach*

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	920.283	2	460.141	3.443	.040	.128
Intercept	13086.420	1	13086.420	97.913	.000	.676
Pre-test	38.283	1	38.283	.286	.595	.006
Gender	918.129	1	918.129	6.870	.012	.128
Error	6281.717	47	133.654			
Total	316100.000	50				
Corrected Total	7202.000	49				

Table 5 shows that the calculated F-ratio is 6.870 and not significant at $p=0.012$ ($P < 0.05$). Hypothesis 2 was accepted. This shows that there is no significant difference between the mean performance score of the male and female students taught chemistry using active learning approach in the secondary schools.

Discussion of Findings

The result of table 2 in the study revealed that the SS2 chemistry students who were taught using active learning approach performed better than those who were taught using lecture method in the secondary schools. The difference in the mean gain is 17.9. This implies that the active learning approach was effective in improving the academic performance of the chemistry students when compared to that of those taught using the convectional lecture method of learning. The effect of active learning approach on the performance of the chemistry students was also significant as shown in table 4 where the F-calculated is 94.061 and significant at $p = 0.00$ ($p, 0.05$), showing a significant difference between the mean performance score of students taught chemistry using active learning approach and those taught using lecture method in senior secondary schools in Rivers State. The use of active learning approach promotes the development of critical thinking through discussion and clarification of ideas which gives the students a greater liberty to advance their own ideas and at the same time benefit from the ideas of others. This finding is in line with that of (Macrothink Insitute, 2023) who reported that practical and experiential learning has been known to enhance motivation to learning chemistry and enable students develop science process skills which helps them to deal with abstract knowledge. The findings agree with the submission of Wolf et al. (2015), and Camacho and Legare (2015), that active learning helps to increase retention in students and

facilitate transfer of knowledge. Also established that when learners are actively involved in their learning, knowledge will be transmitted, and they will effectively apply their knowledge and skills.

Table 3 revealed that female students taught chemistry using active learning approach performed better than their male counterparts with a mean gain difference of 5.4. Further analysis in the table 5 revealed that the calculated F-ratio is 6.870 and not significant at $p=0.012$ ($P < 0.05$). Thus the Hypothesis 2 was accepted implying that there is no significant difference between the mean performance score of the male and female students taught chemistry using active learning approach in the secondary schools. This findings agrees with the submission of Nguyen et al. (2021), that the use of active learning in STEM fields has been linked to improving students learning and retention. Also agrees with Galbraith and Fouch (2007), asserted that active learning techniques enable students to organize and reflect in order to reinforce learning. This implies that gender was not necessarily a significant factor in this regard. Both male and female chemistry students can respond positively to the use of active learning approaches and optimally to enhanced knowledge and improved performance.

Conclusion

The findings of this study have established that active learning approach has the potential to enhance the academic performance of the chemistry students in the secondary schools. To fully adopt active learning approach in teaching and learning of chemistry in the secondary schools, chemistry teachers should acquire a good knowledge on the use of active learning for effective implementation in the classroom. When learners are actively engaged in their learning, transmission of knowledge will take place and the knowledge acquired can be applied in real-life situations. Both male and female students have the potentials to respond favorably to active learning approaches in the secondary school. Therefore, incorporating active learning approach and strategies into classroom produces a more effective learning environment and increased students' participation. This ensures more student engagement in their learning and enhances meaningful learning.

Recommendation

Consequent on the findings of this analysis, the following recommendations were made:

1. Curriculum planners should incorporate the use of active learning approach into the chemistry curriculum to constitute contents and learning experiences.
2. Chemistry teachers should adopt active learning as a learning approach in the teaching and learning of Chemistry at all levels of education to enhance learning and improve students' performance in Chemistry.
3. Government and Educators should organize workshops and provide adequate training facilities on the use of active learning techniques in the secondary schools and encourage teachers to utilize it in teaching and learning of chemistry.

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