

## EFFECTIVENESS OF INDOOR AND OUTDOOR LABORATORY STRATEGIES ON SECONDARY SCHOOL STUDENTS' ACADEMIC PERFORMANCE AND RETENTION IN ECOLOGY IN KATSINA STATE, NIGERIA

Auwali Yazid<sup>1</sup>, Salisu Tsauri Aminu PhD<sup>2</sup>

&

Sani Shamsuddeen<sup>3</sup>

shamsuddeensanibky@gmail.com

08144677354

<sup>1&2</sup>Department of Science and Vocational Education,

Umaru Musa Yar'adua University Katsina

<sup>3</sup>Department of Educational Technology,

Abubakar Tafawa Balewa University Bauchi

### Abstract

This study investigated the effectiveness of indoor and outdoor laboratory strategies on secondary school students' academic performance and retention in ecology in Katsina state, Nigeria. Four objectives, research questions and hypotheses guided the study. A quasi-experimental pre-test, post-test, and delayed post-test design was adopted. The population of the study comprised 4,175 SS II Biology students from 22 public secondary schools in ZEQA Daura, Katsina state involving 130 students drawn from three public secondary schools. The experimental groups received treatment using indoor ( $X_1$ ) and outdoor ( $X_2$ ) laboratory strategies, while the control group was taught using the conventional method ( $X_0$ ). Data were collected using the validated Ecology Performance Test (EPT) with reliability coefficient of 0.84. Mean and standard deviation were used to answer research questions, and independent sample t-test was used to test the hypotheses at the 0.05 level of significance. Findings revealed that students taught using indoor and outdoor laboratory strategies demonstrated significantly higher academic performance, and retention than those taught using conventional method. Outdoor laboratory strategies were particularly effective in enhancing retention. The study concluded that integrating structured indoor and outdoor laboratory activities into ecology instruction can substantially improve students' engagement, understanding, and retention of concepts. Recommendations were made for teachers, curriculum planners, policymakers, and researchers to promote learner-centred, experiential instructional practices.

**Keywords:** Ecology, Indoor Laboratory, Outdoor Laboratory, Academic Performance, Retention.

### Introduction

Education is the foundation of societal development and a vital instrument for empowering individuals with the knowledge, skills, values, and attitudes required for personal growth and national advancement. Educational research explores the processes and practices involved in teaching and learning, including instructional strategies, learner motivation, retention, and academic performance, with the aim of improving educational outcomes and promoting equity (Taber, 2014). Education is not limited to formal classroom settings; it also encompasses informal and lifelong learning environments that significantly shape learners' knowledge, attitudes, interests, and behaviors.

Science education involves the application of scientific knowledge, methods, and processes to teaching and learning (Taber, 2014). Scientists working within related disciplines often share common concepts, methodologies, and analytical tools, which form the basis of scientific inquiry and instruction (Singh & Yaduvanshi, 2015). One of the major objectives of science education is to develop students' interest and positive attitudes toward science and technology, as modern societies rely heavily on scientific and technological advancement. Consequently, science teachers are expected to adopt instructional strategies that promote active learning, curiosity, and long-term retention of scientific knowledge.

Biology is a core science subject taught at the secondary school level and focuses on the study of living organisms, including humans, and their interactions with one another and the environment (Michael, 2021). Abdurrashid (2021) defined Biology as a branch of science that studies living organisms and their functions, while Ahmad (2020) described it as the systematic study of living things and their interactions with the environment. Biology comprises several branches such as zoology, botany, ecology, genetics, physiology, microbiology, and evolution, many of which are directly linked to societal issues such as health, agriculture, and environmental sustainability. Despite the importance of Biology, studies have shown that many teachers rely predominantly on the lecture method, which often limits students' active participation and reduces interest, academic performance, and retention (Eyeni, 2023). Effective Biology teaching therefore requires learner-centred strategies that actively engage students in the teaching and learning process. Such strategies include laboratory activities, inquiry-based learning, cooperative learning, problem-solving, and fieldwork.

Ecology, a major branch of Biology, is defined as the study of the relationships between living organisms and their physical environment (Ecological Society of America (ESA), 2022; Ndokwo, 2018). It involves understanding interactions among organisms in terrestrial, freshwater, and marine environments (Maikano, 2019). Ecological knowledge is essential for environmental conservation, natural resource management, public health, agriculture, and sustainable development. Due to its practical and environmental nature, Ecology is best taught through direct observation and hands-on experiences, both within the classroom and in natural habitats.

Indoor laboratory strategies involve structured experiments, investigations, and analyses conducted within classrooms or laboratories using models, specimens, and equipment, while outdoor laboratory strategies allow students to observe organisms and ecological processes in their natural environments. These approaches promote experiential learning, critical thinking, and meaningful understanding of ecological concepts. Interest, academic performance, and retention are key variables influenced by teaching strategies. Interest is a psychological state that directs attention and facilitates learning (Renninger & Hidi, cited in Oka & Samuel, 2020), while academic performance reflects the extent to which learners benefit from instruction (Owenbiugie & Iyoha, 2017). Retention refers to the ability to recall learned information over time and is strongly influenced by the nature of instructional strategies used (Aminu, 2017; Wada, 2018). Given the cultural, environmental, and educational context of Katsina State, as well as the persistent challenges of low student interest and poor performance in Ecology, this study investigates the Effectiveness of indoor and outdoor laboratory strategies on students' academic performance and retention in Ecology among secondary schools.

### **Objectives of the Study**

The main objective of this study are:

1. examine the effect of the indoor laboratory strategy on students' academic performance in ecology in secondary schools in Katsina state, Nigeria;
2. assess the effect of the indoor laboratory strategy on students' retention in ecology in secondary schools in Katsina state, Nigeria;
3. examine the effect of the outdoor laboratory strategy on students' academic performance in ecology in secondary schools in Katsina state, Nigeria
4. assess the effect of the outdoor laboratory strategy on students' retention in ecology in secondary schools in Katsina state, Nigeria.

### **Research Questions**

The following research questions guided the study:

1. What is the effect of the indoor laboratory strategy on students' academic performance in ecology in secondary schools in Katsina state, Nigeria?
2. What is the effect of the indoor laboratory strategy on students' retention in ecology in secondary schools in Katsina state, Nigeria?
3. What is the effect of the outdoor laboratory strategy on students' academic performance in ecology in secondary schools in Katsina state, Nigeria?
4. What is the effect of the outdoor laboratory strategy on students' retention in ecology in secondary schools in Katsina state, Nigeria?

### **Hypotheses**

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

**H<sub>01</sub>:** There is no significant difference in students' academic performance in ecology between those taught using the indoor laboratory strategy and those taught using the conventional method in secondary schools in Katsina state, Nigeria.

**H<sub>02</sub>:** There is no significant difference in students’ retention in ecology between those taught using the indoor laboratory strategy and those taught using the conventional method in secondary schools in Katsina state, Nigeria.

**H<sub>03</sub>:** There is no significant difference in students’ academic performance in ecology between those taught using the outdoor laboratory strategy and those taught using the conventional method in secondary schools in Katsina state, Nigeria.

**H<sub>04</sub>:** There is no significant difference in students’ retention in ecology between those taught using the outdoor laboratory strategy and those taught using the conventional method in secondary schools in Katsina state, Nigeria.

**Methodology**

The study adopted a quasi-experimental research design involving pre-test and post-test measures. The design comprised two groups: an experimental group (EG) and a control group (CG). All sampled students were pre-tested (O<sub>1</sub>) to establish their initial academic equivalence. The experimental group was exposed to treatment through indoor laboratory strategy (X<sub>1</sub>) and outdoor laboratory strategy (X<sub>2</sub>), while the control group was taught using the conventional method (X<sub>0</sub>). After the treatment, all groups were administered a post-test (O<sub>2</sub>) to determine the effect of the instructional strategies on students’ academic performance. A delayed post-test (O<sub>3</sub>) was subsequently administered to assess the effect of the treatments on students’ retention ability. The population of the study covered four thousand, one hundred and seventy five (4,175), male and female SS II, Biology students during the 2024/2025 academic session in Katsina state, Nigeria. The sample size of the study consists of one hundred and thirty (130), male and female SS II students selected from the population using cluster random sampling technique by balloting. Data were collected using the validated Ecology Performance Test (EPT) with reliability coefficient of 0.84. Mean and standard deviations were used to answer the research questions while, independent samples t-test was used to test the hypotheses.

**Results**

**Research Question 1:** What is the effect of the indoor laboratory strategy on students’ performance in ecology in secondary schools in Katsina state, Nigeria?

**Table 1:** Mean difference of students' academic performance between experimental group 1 and control group

Groups	N	Mean	Std.	Std. Error Mean	Mean difference
Experimental Group 1	49	48.37	11.745	1.678	37.96
Control Group	41	10.41	4.416	0.69	

Table 1 showed that the mean score of students’ academic performance taught ecology using indoor laboratory strategy is (48.370), the standard deviation is (11.745) and that of conventional method is (10.410), the standard deviation is (4.416) and also the difference mean score is (37.960). This indicated that, students taught ecology using indoor laboratory strategy have high academic performance than those exposed to conventional method.

**Research Question 2:** What is the effect of the indoor laboratory strategy on students’ retention in ecology in secondary schools in Katsina state, Nigeria?

**Table 2:** Mean difference of students retention between experimental group 1 and control group

Groups	N	Mean	Std.	Mean difference
Experimental Group 1	49	37.220	11.852	23.680
Control Group	41	13.540	3.722	

Table 2 showed that the mean score of students' retention of experimental group 1 is (37.220), the standard deviation is (11.852), while that of control group is (13.540). The standard deviation is (3.722), and also the mean differences is (23.680). This indicated that, students taught ecology using indoor laboratory strategy have high retention than those exposed to conventional method.

**Research Question 3:** What is the effect of the outdoor laboratory strategy on students' academic performance in ecology in secondary schools in Katsina state, Nigeria?

**Table 3:** Mean difference of students' academic performance between experimental group two and control group

Groups	N	Mean	Std.	Std. Error Mean	Mean difference
Experimental Group 2	40	45.900	8.770	1.387	35.490
Lecture method	41	10.410	4.416	0.690	

Table 3 showed that the mean score of students' academic performance of experimental group 2 is (45.900), the standard deviation is (8.770), while that of conventional group is (10.410) and the standard deviation is (4.416). The Mean difference scores is (35.490). This indicated that, students taught Ecology using outdoor laboratory strategy have high academic performance than those exposed to conventional method.

**Research Question 4:** What is the effect of the outdoor laboratory strategy on students' retention in ecology in secondary schools in Katsina state, Nigeria?

**Table 4:** Mean difference of students' retention between experimental group 2 and control group.

Groups	N	Mean	Std.	Std. Error Mean	Mean difference
Outdoor teaching Strategy	40	39.600	9.779	1.546	23.680
Control Group	41	13.540	3.722	0.581	

Table 4 showed that the mean score of students' retention of experimental group 2 is (39.60), the standard deviation is (9.770) and that of control group is (13.54), the standard deviation is (3.722). The Mean difference scores is (23.680). This indicated that, students taught ecology using outdoor laboratory strategy have high retention than those exposed to conventional method.

### Hypotheses

**Ho.:** There is no significant difference in students' academic performance in ecology between those taught using the indoor laboratory strategy and those taught using the conventional method in secondary schools in Katsina state, Nigeria.

**Table 5:** t-test result on student's academic performance in ecology between experimental group 1 and control group.

Group	N	Mean	Std.	DF	T-value	P-value	Remark
Experimental Group 1	49	48.37	11.74	88	19.55	0.0	Significant
Conventional Method	41	10.41	4.416				

Table 5 showed that p-value (observed) = 0.000 is less than  $\alpha$ -value of 0.05 at df = 88. Since the observed p-value = 0.000 < 0.05 then the null hypothesis (H02.) states that: “ There is no significant difference on academic performance in ecology between those taught using indoor laboratory strategy and those taught with conventional method in secondary schools in Katsina state Nigeria is rejected. This means that there exist statistically significant difference between experimental group 1 and control group.

**Ho2:** There is no significant difference in students' retention in ecology between those taught using the indoor laboratory strategy and those taught using the conventional method in secondary schools in Katsina state, Nigeria.

**Table 6:** t-test result on students' retention in ecology between experimental group 1 and control group.

Group	N	Mean	Std.	DF	T-value	P-value	Remark
Experimental	49	37.22	11.82	88	12.29	0.0	Significant
Control	41	13.54	3.722				

Table 6 showed that p-value (observed) = 0.000 is less than  $\alpha$ -value of 0.05 at df = 88. Since the observed p-value = 0.000 < 0.05 then the null hypothesis (Ho2) which states that: "there is no significant difference in students' retention in ecology between those taught using the indoor laboratory strategy and those taught using the conventional method in Katsina state, Nigeria" is rejected. This means that there exist statistically significant difference between experimental group 1 and control group.

**Ho3:** There is no significant difference in students’ academic performance in ecology between those taught using the outdoor laboratory strategy and those taught using conventional method in secondary schools in Katsina state, Nigeria.

**Table 7:** t-test result on performance in biology for experimental group two and control group.

Group	N	Mean	Std.	DF	T-value	P-value	Remark
Indoor strategy	49	45.90	8.770	79	23.085	0.0	Significant
Lecture method	41	10.41	4.416				

Table 7 showed that p-value (observed) = 0.000 is less than  $\alpha$ -value of 0.05 at df = 79. Since the observed p-value = 0.000 < 0.05 then the null hypothesis (H03) which states that: “ there is no significant difference in students’ academic performance in ecology between those taught using the outdoor laboratory strategy and those taught using conventional method in Katsina state, Nigeria. ” is rejected. This means that there exist statistically significant difference between experimental group 2 and control group.

**H<sub>04</sub>:** There is no significant difference in students' retention in ecology between those taught using the outdoor laboratory strategy and those taught using the conventional method in secondary schools in Katsina state, Nigeria.

**Table 8:** t-test result on students' retention ability score for experimental group two and control group.

Group	N	Mean	Std.	DF	T-value	P-value	Remark
Experimental Two	40	39.60	9.779	79	15.93	0.0	Significant
Control	41	13.54	3.722				

Table 8 showed that p-value (observed) = 0.000 is less than  $\alpha$ -value of 0.05 at  $df = 79$ . Since the observed p-value = 0.000 < 0.05 then the hypothesis which states that: “ there is no significant difference in students' retention in ecology between those taught using the outdoor laboratory strategy and those taught using the conventional method in secondary schools in Katsina state, Nigeria" is rejected. Therefore, there exist statistically significant difference between experimental group 2 and control group.

**Discussion of Findings**

This study examined the impact of indoor and outdoor laboratory strategies on students' academic performance and retention in ecology in secondary schools in Katsina state, Nigeria. The findings revealed that students exposed to indoor and outdoor laboratory strategies performed significantly better and demonstrated higher retention in ecology than those taught using the conventional method. The findings of this study are consistent with those of Mahmud et al. (2022), who reported that the indoor and outdoor laboratory strategies significantly favored students in the experimental group in ecology concepts. This supports the present study's result that outdoor laboratory strategies enhance students' academic performance in ecology. Similarly, Muhammad, Bernadette and Sani (2021) found no significant difference in achievement scores between male and female students taught using the outdoor laboratory method, indicating that the strategy is effective across gender. This aligns with the present study's findings, which suggest that outdoor laboratory strategy is effective for both male and female students.

Furthermore, Edarho (2020) reported that students taught using outdoor science activities achieved higher mean scores in both achievement and retention than those taught without outdoor activities. This finding corroborates the present study's result that outdoor laboratory strategies significantly improve students' academic performance and retention in ecology. In addition, Maikano (2019) found that students exposed to outdoor laboratory instructional strategies retained learned concepts better than those exposed to indoor laboratory strategies, which supports the current study's finding that outdoor laboratory strategies enhance students' retention ability in ecology.

**Conclusion**

The study concluded that both indoor and outdoor laboratory strategies are effective instructional approaches for improving students' interest, academic performance, and retention in ecology.

## Recommendations

Based on the findings, the study made the following recommendations:

1. Biology teachers should adopt indoor and outdoor laboratory strategies in teaching ecology and other practical aspects of Biology to enhance students' interest, understanding, and retention.
2. Educational authorities and curriculum developers should incorporate structured laboratory-based and field-based activities into the secondary school Biology curriculum.
3. Schools should be supported with the necessary infrastructure, equipment and resources to facilitate effective indoor and outdoor laboratory instruction.
4. Researchers should explore further studies with the efficacy of these strategies in other science subjects and different educational contexts.

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