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Effects of Model-Lead-Test Strategy on Interest and Performance in Ecology Concept among Secondary School Biology Students in Tudun Wada Local Government Area, Kano State, Nigeria

SAIDU, Abba[1]
saiduabba1027@gmail.com
+2348036471421

BASHIR, Wada[2]
wadabashir1@gmail.com
+2348037880889

BUHARI, Nuhu Idris[3]
nuhubuharii@gamail.com
+2348065029298

[1] Department of Natural Science Education, University of Science and Technology Education, Wudil Kano State, Nigeria
[2]Department of Educational Foundation, University of Science and Technology Education, Wudil Kano State, Nigeria
[3]Faculty of Science & Technology Education, University of Science and Technology Education, Wudil Kano State, Nigeria

Abstract

This study examined the difference in interest and academic performance between senior secondary school students taught selected Ecology concepts through the Model-Lead-Test (MLT) instructional strategy and students taught the same concepts through the conventional lecture method in Tudun Wada Local Government Area, Kano State, Nigeria. A quasi-experimental pretest–posttest control-group design was adopted. The study involved 128 Senior Secondary II Biology students: 65 in the MLT group and 63 in the control group. Data were collected using a Biology Performance Test (BPT) and a Biology Students' Interest Questionnaire (BSIQ). Descriptive statistics and independent-samples t-tests were used for data principal analyses. The descriptive results show a higher mean interest score for the MLT group (M = 3.92, SD = 0.42) than the control group (M = 3.25, SD = 0.51), and a higher mean performance score for the MLT group (M = 68.25, SD = 8.50) than the control group (M = 61.10, SD = 7.90). Data collected were analyzed using mean, standard deviation, and t-test statistics to answer the research questions and tested the hypotheses at the 0.05 level of significance. Findings revealed that students taught using the MLT instructional strategy shows higher interest level and performed significantly better in Biology concepts than those taught using lecture method. The study concludes that the MLT approach enhances learning and students' interest. The study recommends that teachers, curriculum planners, and professional bodies such as STAN should adopt the strategy to improve Biology teaching and learning.

Keywords: academic performance; Biology; Ecology, Model-Lead-Test; students' interest

Introduction

Science education supports students' development of scientific knowledge, evidence-based reasoning, and problem-solving skills. Biology is an important senior secondary school subject because it introduces students to living systems and provides foundational knowledge relevant to health, agriculture, environmental studies, and other biological disciplines. Effective Biology teaching therefore requires approaches that help students understand concepts and remain engaged in learning. Students' interest is an important affective dimension of learning. It can support attention, engagement, and persistence, although it develops through interactions between students and their learning environments (Hidi & Renninger, 2006). In Biology classrooms, instructional approaches that involve students in purposeful activity, explanation, and feedback may help sustain interest. Onu, Anyaegbunam and Uzoigwe (2020), for example, reported that students taught Biology through a collaborative instructional strategy showed stronger interest and achievement than students taught using convention method such as lecture method. Awosika and Okoli (2023) also investigated mind-mapping instruction as a means of supporting students' academic interest in Biology. Academic performance reflects students' demonstrated learning as measured through assessments. Performance may be affected by methods of instruction, opportunities to practice, prior knowledge, learning resources, and the quality of feedback. Evidence from active-learning research suggests that learner

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participation can support learning outcomes. For example, Taraban et al. (2007) examined active-learning experiences in high-school Biology, while Freeman et al. (2014) reported higher examination performance under active learning than traditional method across a broad range of science, technology, engineering and mathematics studies. Similarly, Adogbeji (2026) in his work titled: Effects of Scaffolding on Biology Students' Achievements and Motivations in Secondary Schools in Delta Central Senatorial District, reported higher achievement and motivation among students taught using scaffolding than among those taught using the conventional lecture method. This is useful supporting evidence for considering structured, guided instruction in Biology as seen in MLT instructional strategy. The Model-Lead-Test instructional strategy follows a structured progression. That is the teacher models a task or process, students practice with guidance, and students then demonstrate their understanding or skill independently. The sequence is intended to make expectations explicit and provide opportunities for guided practice and independent application. Previous studies have examined MLT in subjects such as Organic Chemistry and Mathematics (Itikpo et al., 2021; Obaje et al., 2025), but evidence from secondary school Biology in Tudun Wada Local Government Area remains limited in the field of MLT application. The present study therefore investigates the effect of MLT instructional strategy on interest and academic performance of Biology students in Tudun Wada local government area, Kano state.

Statement of the Problem

Biology is an important science subject in Nigerian secondary schools because it provides learners with knowledge of living organisms, their interactions with the environment and the biological principles underlying health, agriculture and environmental sustainability. The effective teaching of Biology requires instructional strategies that promote students' understanding, interest and ability to apply biological concepts. However, where teaching is predominantly teacher-centered and provides limited opportunities for active participation, guided practice and independent application, students may experience difficulties in developing meaningful understanding and sustained interest in the subject. Several researchers (Onu et al, 2020) have investigated alternative instructional strategies for improving students' interest and academic achievement in Biology. Other studies have also examined learner-centered approaches, including scaffolding and inquiry-based instruction, with findings suggesting that instructional strategies can influence students' learning outcomes. These studies underscore the importance of identifying effective approaches to Biology teaching. The Model-Lead-Test (MLT) instructional strategy offers a structured approach involving teacher modelling, guided learner practice and independent performance. Okwelle and Omeodu (2016) discussed its potential for improving Physics instruction in Nigerian secondary schools, while Itikpo, Friday and Delmang (2021) reported a significant effect of MLT on students' achievement in organic Chemistry in Benue State. Uzenda, Imoko and Atovigba (2024) also investigated MLT in relation to students' interest in Algebra. Although these studies provide relevant evidence, their findings do not establish the effectiveness of MLT for teaching Biology, particularly selected Ecology concepts. The effectiveness of MLT in promoting both students' interest and academic performance in Biology within Tudun Wada Local Government Area, Kano State, therefore, requires empirical investigation. Specifically, it is necessary to determine whether students taught using MLT differ significantly from those taught using the conventional lecture method in their interest in Biology and academic performance in selected Ecology concepts. The problem of this study is, therefore, the insufficient empirical evidence on the effectiveness of Model-Lead-Test instructional strategy in improving students' interest and academic performance in selected Ecology concepts in Biology in Tudun Wada Local Government Area, Kano State. The study seeks to address this gap by comparing the learning outcomes of students exposed to MLT with those taught using the conventional lecture method.

Objectives of the Study

The objectives of this study are to:

1. Determine the difference in interest between students taught Biology concepts using MLT and those taught the same concepts using the lecture method.
2. Determine the difference in academic performance between students taught Biology concepts using MLT and those taught the same concepts using the lecture method.

Research Questions

The following questions were formulated to guide the study:

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1. What is the difference between the interest levels of students taught Biology concepts using MLT and those taught the same concepts using the lecture method?
2. What is the difference between the mean academic performance scores of students taught Biology concepts using MLT and those taught the same concepts using the lecture method?

Null Hypotheses

The following null hypotheses are to be tested at the 0.05 level of significance:

H_{01}: There is no statistically significant difference in the interest scores of students taught Biology concepts using MLT and those taught the same concepts using the lecture method.

H_{02}: There is no statistically significant difference in the mean academic performance scores of students taught Biology concepts using MLT and those taught the same concepts using the lecture method.

Research Methodology

The study used a quasi-experimental pretest–posttest non-equivalent control-group design. Intact classes were used rather than randomly assigning individual students to conditions. The experimental group received instruction through MLT, while the control group received instruction through the conventional lecture method. Both groups were subjected to pretests before the intervention and posttests thereafter.

The design is represented as follows:

Experimental group: O_1 — X_1 — O_2

Control group: O_3 — X_0 — O_4

O_1 and O_3 represent pretests; X_1 represents MLT instruction; X_0 represents conventional instruction; and O_2 and O_4 represent posttests.

The population of the study comprised 1,114 Senior Secondary II students offering Biology in public secondary schools in Tudun Wada Local Government Area during the 2024/2025 academic session, including 708 male and 406 female students. The sample comprised 128 students, with 65 in the experimental group and 63 in the control group. A sample size of 128 students was used for the study. One intact class was used in each of the selected schools for both experimental and control groups. Using simple random sampling technique, four schools were selected. These schools were pretested and the results obtained were subjected to ANOVA test and thereafter Scheffes' test to determine two groups that were statistically insignificant in their ability. Simple random sampling technique (balloting method) was used to assign the groups as experimental and control group respectively. The instruments for data collection were Biology Performance Test (BPT) with 30 multiple-choice questions adapted from past question papers of West African Examination Council (WAEC) and National Examinations Council (NECO) 2018-2023, and Biology Students Interest Questionnaire (BSIQ) adapted from Xuans (2020). The BSIQ instrument is a 5-point Likert scale (Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree) meant to determine the level of students' interest in Ecology concepts. The two instruments were reviewed for face and content validity by experts in science education from Aliko Dangote University of science and Technology Wudil, Kano, and an experienced secondary school Biology teacher. Their corrections, suggestions, and recommendations regarding the face and content validity of the instruments were effected and used to produce the final version of the instruments. The instruments BAT and BSIQ were also tested for reliability using PPMC and found to be 0.97 and 0.82 respectively.

Presentation of Results

The results for this study are presented as follows:

Research Question 1: What is the difference between the interest levels of students taught Biology concepts using MLT and those taught the same concepts using the lecture method?

Descriptive statistics of mean and Standard Deviation were used to answer the research question and the summary of the result is presented in Table 1

Table 1: Mean and Standard Deviation Posttest of EG and CG Interest level

Group	N	Mean	SD	MD
EG	65	3.92	0.42	
				0.67

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CG	63	3.25	0.51

The reported posttest mean interest score was higher in the MLT group (M = 3.92, SD = 0.42) than in the lecture group (M = 3.25, SD = 0.51), a mean difference of 0.67 in favour of the experimental group. This implied that the treatment appears to have effect on the experimental group.

Hypothesis 1: There is no statistically significant difference in the mean interest scores of students taught Biology concepts using MLT and those taught the same concepts using the lecture method.

Table 2: t-test Analysis of Posttest Mean Scores of the EG and CG

Group	N	Mean	SD	Df	T	P	Remark
EG	65	3.92	0.42				
				126	6.78	0.000	Sig
CG	63	3.25	0.51				

Significant at p ≤ 0.05

Table 2 shows that the t-test 6.78, and p-value 0.000 at degree of freedom 126. Since the p-value is 0.000 at 0.05, it means that there is a significant difference in favour of the experimental group exposed to MLT teaching strategy. With this result, the null hypothesis 1 is rejected.

Research Question 2: What is the difference between the mean academic performance scores of students taught Biology concepts using MLT and those taught the same concepts using the lecture method?

Descriptive statistics of mean and Standard Deviation were used to answer the research question and the summary of the result is presented in Table 3

Table 3: Mean and SD of Posttest of EG and CG on Academic Performance

Group	N	Mean	SD	MD
EG	65	68.25	8.50	
				7.15
CG	63	61.10	7.90	

The reported posttest mean performance score was higher in the MLT group (M = 68.25, SD = 8.50) than in the lecture group (M = 61.10, SD = 7.90), a mean difference of 7.15 in favour of the experimental group. This implied that the treatment appears to have effect on the experimental group.

Hypothesis 2: There is no statistically significant difference in the mean academic performance scores of students taught Biology concepts using MLT and those taught the same concepts using the lecture method.

Table 4: t-test Analysis of Posttest Mean Scores of the EG and CG

Group	N	Mean	SD	Df	t	P	Remark
EG	65	68.25	8.50				
				126	3.85	0.000	Sig
CG	63	61.10	7.90				

Significant at p ≤ 0.05.

Table 4 shows that the t-test 3.85, and p-value 0.000 at degree of freedom 126. Since the p-value is 0.000 at 0.05, it means that there is a significant difference in favour of the experimental group exposed to MLT teaching strategy. With this result, the null hypothesis is rejected.

Discussion of Findings

The descriptive findings in Table 2 indicate higher posttest interest scores among students taught with MLT than among students taught through the lecture method. One plausible explanation is that the model–guided practice–independent performance sequence gives students clear examples, opportunities to participate, and structured practice. These features may help students feel more capable of engaging with Ecology concepts. This interpretation is consistent with literature

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that associates active participation and learner-centered approaches with students' interest. For instance Adebayo (2020) reported that active instructional strategies foster curiosity, interest and motivation in science learning. Furthermore, the significant improvement in students' interest aligns with the work of Okebukola and Jegede (2018), who reported that active participation and feedback promote students' interest, motivation and engagement in learning.

The result findings in experimental group, Table 4 also had a higher reported mean performance score than the lecture group. This could be as a result of modelling which can make a process or expected response explicit, guides practice, provides opportunities to correct misunderstandings, and independent practice which allows students to demonstrate learning. These features offer a plausible explanation for the mean difference obtained. The finding is broadly consistent with research on active learning in Biology and STEM education (Taraban et al., 2007; Freeman et al., 2014). Usman (2019) also reported in his study that active learner-centred instructional approaches significantly improve science performance compared to lecture methods.

Conclusion

Based on the findings of this study, the following conclusions were drawn:

1. Model-Lead-Test instructional strategy provides a structured and learner-centred approach capable of enhancing students' interest in Ecology concepts by involving them in modelling, guided practice and independent learning activities. The MLT was found to significantly improve students' interest.
2. Model-Lead-Test instructional strategy has the potential to improve students' academic performance in Ecology concepts by providing opportunities for active participation, practice, feedback and application of learned concepts.

Recommendations

1. Biology teachers should consider using MLT when teaching concepts that benefit from explicit demonstration, guided practice, and independent application, while adapting the strategy to lesson objectives and available resources.
2. Professional development for Biology teachers should include practical demonstrations of how to model concepts, guide student practice, and assess independent application.
3. Further studies should use clearly reported pretest-adjusted analyses, larger and more diverse samples, and transparent reporting of implementation procedures to examine whether the findings generalize to other Biology topics and locations.

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