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Effects of Science Process Skills and Problem-Solving Skills Instructions on Students' Academic Achievement in Ecology in Oyo East Local Government Area, Oyo State

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Abstract

The declining performance of students in Ecology has been largely attributed to the continued use of ineffective instructional approaches and limited student engagement in science classrooms. This study examined the effects of Science Process Skills instruction and Problem-Solving Skills strategies on Senior Secondary School students' academic achievement in Ecology in Oyo East Local Government Area, Oyo State. One hypothesis was formulated and tested at the 0.05 level of significance. A quasi-experimental research design was adopted. The population comprised 1,240 Senior Secondary School II Biology students in the study area, from which 97 students were selected through intact classes from three sampled schools. The Ecology Achievement Test (EAT)(KR – 20 = 0.87) was used for data collection, with pretest scores serving as covariates, while instructional guides were employed for treatment delivery. Data were analyzed using Analysis of Covariance (ANCOVA). There was a significant main effect of treatments on students' academic achievement in Ecology ($F_{(2, 92)} = 44.908$, $p < 0.05$, partial $\eta^2 = 0.494$). The study concludes that Science Process Skills instruction and Problem-Solving Skills strategies significantly enhance students' achievement in Ecology compared to the Traditional Teaching method. It is therefore recommended that Biology teachers adopt Science Process Skills and Problem-Solving instructional approaches to improve students' understanding, engagement, and academic performance in Ecology.

Keywords: *Academic achievement, Ecology, Science process skills instruction, Problem-solving skills strategy.*

INTRODUCTION

Biology occupies a central position in science education because of its relevance to human health, environmental sustainability, agriculture, and technological development. Among the various branches of Biology, Ecology is particularly important because it helps students understand the interactions between living organisms and their environment. Knowledge of ecological principles equips learners with the skills required to address contemporary environmental challenges such as climate change, biodiversity loss, pollution, and resource management. Despite the importance of Ecology, students' academic achievement in Biology, particularly in Ecology-related concepts, has remained unsatisfactory in many secondary schools in Nigeria. This persistent underachievement has generated concern among educators, curriculum planners, and policymakers.

Several factors have been identified as contributors to students' poor achievement in Biology. These include inadequate instructional materials, insufficient laboratory facilities, overcrowded classrooms, poor study habits, low motivation, abstract presentation of biological concepts, inadequate teacher preparation, and inappropriate teaching methods. Among these factors, instructional strategy has consistently emerged as one of the most influential determinants of students' learning outcomes. In many classrooms, Biology instruction continues to rely heavily on the traditional teaching strategy, which is predominantly teacher-centred and characterized by lectures, note-taking, memorization of facts, and limited student participation. Under this approach, students often assume passive roles while teachers dominate classroom activities. Consequently, learners are denied opportunities to actively engage in scientific inquiry, critical thinking, experimentation, and problem-solving processes that are essential for meaningful learning in Biology.

The limitations of the traditional teaching strategy have been widely documented. The approach often emphasizes the transmission of information rather than the development of scientific skills and competencies. As a result, students may

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acquire factual knowledge without developing the ability to investigate biological phenomena, analyze ecological problems, formulate hypotheses, or draw logical conclusions. This challenge is particularly evident in Ecology, where effective learning requires observation, inquiry, experimentation, data interpretation, and problem-solving abilities. The need to address these shortcomings has led researchers and educators to advocate the adoption of learner-centred instructional approaches capable of promoting deeper understanding and improved academic achievement.

One such approach is Science Process Skills instruction. Science process skills refer to the cognitive and psychomotor abilities used by scientists in generating knowledge and solving scientific problems. These skills include observing, classifying, measuring, predicting, hypothesizing, experimenting, interpreting data, and communicating findings. Through Science Process Skills instruction, students actively participate in scientific investigations and construct knowledge through firsthand experiences. This approach encourages learners to become active participants rather than passive recipients of information. Support for the effectiveness of Science Process Skills instruction is evident in the study titled Impact of Inquiry-Based Instruction on Science Process Skills Acquisition in Ecology among Secondary Schools Students in Katsina State, Nigeria (Isa et al., 2025). The study found that inquiry-based instruction significantly enhanced students' science process skills acquisition in Ecology when compared with the conventional lecture method. The researchers concluded that active involvement in scientific investigations improves students' understanding of ecological concepts and promotes better learning outcomes.

Similarly, the study titled Enhancing Secondary School Students' Science Process Skills through Guided Inquiry-Based Laboratory Activities in Biology (Chengere et al., 2025) reported that students exposed to guided inquiry-based laboratory activities achieved significantly higher science process skills than those taught using traditional laboratory methods. The study emphasized that hands-on investigation, experimentation, and active engagement contributed to improved understanding, critical thinking, and academic achievement in Biology. Further evidence was provided by the study titled Effectiveness of Inquiry-Based Learning in Enhancing Science Process Skills among Secondary School Students in Anambra State (Obienyem, 2025). The findings revealed that inquiry-based learning significantly improved students' abilities to observe, hypothesize, analyze data, and interpret scientific information. The study further highlighted the importance of student-centred learning environments in promoting meaningful science learning and preparing learners for scientific careers. The significance of science process skills in promoting academic achievement has also been demonstrated through broader empirical evidence. The study titled The Relationship between Scientific Process Skills and Science Achievement: A Meta-Analysis Study (Dolapcioglu & Subasi, 2022) synthesized findings from multiple studies and established a significant positive relationship between scientific process skills and science achievement. The study reported a moderate-to-high effect size, indicating that students who possess stronger science process skills tend to achieve better academic outcomes in science subjects.

Another instructional approach that has gained attention in science education is Problem-Solving Skills instruction. Problem-solving skills involve the ability to identify problems, analyze situations, generate possible solutions, evaluate alternatives, and implement appropriate strategies. In Biology, problem-solving instruction encourages students to apply scientific knowledge to real-life situations and develop higher-order thinking skills. Rather than memorizing facts, learners are challenged to explore solutions to biological and environmental issues, thereby enhancing conceptual understanding and academic performance. The effectiveness of problem-solving approaches has been demonstrated in several studies. The study titled The Effects of Problem-Based Learning on Academic Achievement in Ecology Concepts among Science Education Students in Gusau (Yahaya, 2023) found that students taught Ecology through problem-based learning achieved significantly higher academic performance than those taught using conventional teaching methods. The study attributed the improvement to increased learner participation, critical thinking, and application of knowledge to practical situations.

Similarly, the study titled Effects of Paper-Based Problem Scenarios on High School Biological Problem-Solving Skills and Academic Achievement (Nigussie et al., 2025) reported that students exposed to structured problem scenarios performed significantly better in both academic achievement and problem-solving abilities than those in the control group. The study concluded that problem-solving-oriented instruction promotes meaningful learning and enhances students' capacity to address scientific challenges. Support for the use of problem-solving approaches was further provided by the study titled Effects of Guided Discovery and Problem-Solving Instructional Strategies on Achievement and Retention of Biology Students in Delta Central Senatorial District, Nigeria (Egbes & Ajaja, 2023). The study found that students taught through guided discovery and problem-solving strategies recorded significantly higher achievement and retention scores than those taught using lecture methods. The researchers concluded that active learning approaches encourage deeper understanding and long-term retention of biological concepts.

Beyond individual studies, strong empirical evidence exists regarding the relationship between problem-solving skills and academic achievement. The study titled The Relationship between Problem-Solving Skills and Student Academic Achievement: A Meta-Analysis in Education (Banawi et al., 2024) established a strong positive relationship between problem-solving ability and students' learning outcomes. The study reported that problem-solving skills accounted for a substantial proportion of students' academic success across different educational settings, highlighting their importance in effective learning. Furthermore, innovative learning environments that integrate collaboration and problem-solving

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have also demonstrated positive outcomes. The study titled An Escape Room-Based Computer-Supported Collaborative Learning Approach to Enhancing Students' Learning Achievement, Collaboration Awareness, Learning Motivation and Problem-Solving Skills (Chang et al., 2025) found that students exposed to interactive and collaborative problem-solving activities significantly outperformed those taught through conventional instructional methods. The study emphasized that active engagement and collaborative learning experiences contribute positively to students' academic achievement and motivation.

Although previous studies have independently established the effectiveness of science process skills instruction and problem-solving skills instruction, there is limited empirical evidence comparing the relative effectiveness of these approaches in improving students' academic achievement in Ecology within Oyo East Local Government Area of Oyo State. Most existing studies have focused on Biology achievement in general or have been conducted in other geographical locations. This creates a gap in the literature that necessitates further investigation. Therefore, this study seeks to examine the effect of Science Process Skills and Problem-Solving Skills instructions on students' academic achievement in Ecology in Oyo East Local Government Area, Oyo State, with a view to identifying instructional approaches capable of improving students' learning outcomes in Ecology.

Statement of the Problem

Despite the importance of Ecology in helping students understand environmental relationships and develop scientific literacy, students' academic achievement in the subject has continued to be unsatisfactory in many secondary schools. This persistent underachievement has been linked to several factors, particularly the continued reliance on traditional teaching strategies that emphasize rote learning, teacher domination of classroom activities, and limited student participation. Such approaches often fail to develop essential scientific competencies such as observation, investigation, critical thinking, experimentation, and problem-solving, which are necessary for meaningful learning of ecological concepts. Although studies have shown that learner-centred approaches such as Science Process Skills instruction and Problem-Solving Skills instruction can improve students' understanding and achievement in science-related subjects, these instructional strategies are not widely utilized in the teaching of Ecology in many schools. Furthermore, there is limited empirical evidence on the comparative effectiveness of these instructional approaches on students' academic achievement in Ecology within Oyo East Local Government Area of Oyo State. It is against this background that this study seeks to investigate the effect of Science Process Skills and Problem-Solving Skills instructions on students' academic achievement in Ecology, with a view to identifying more effective instructional approaches for improving learning outcomes in the subject.

Aim and Objective of the Study

The aim of this study is to investigate the effects of science process skills instruction and problem-solving skills on students' academic achievement in Ecology in Oyo East Local Government Area, Oyo State.

The objective is to:

i. determine the main effect of treatments on students' academic achievement in Ecology in Oyo East Local Government Area, Oyo State.

Hypothesis

The null hypothesis below would be tested at 0.05 level of significance:

H_0: There will be no significant main effect of treatments on students' academic achievement in Ecology in Oyo East Local Government Area, Oyo State.

Methodology

This study adopted a quasi-experimental pretest-posttest control group design. The population comprised 1,240 Senior Secondary School II (SS II) students offering Biology in public secondary schools in Oyo East Local Government Area, Oyo State. Three co-educational public secondary schools were purposively selected based on the availability of qualified Biology teachers and adequate instructional facilities. A total of ninety-six (96) students drawn from intact classes participated in the study and were randomly assigned to three groups: Science Process Skills Instruction, Problem-Solving Skills Instruction, and Traditional Teaching Method. The instrument used for data collection was the Ecology Achievement Test (EAT), which was validated by experts in Biology Education and Measurement and Evaluation, while its reliability was established through a pilot study using the Kuder-Richardson Formula 20 (KR-20), yielding a coefficient of 0.87. Prior to the commencement of the study, Biology teachers were trained as research assistants on the implementation of the instructional strategies. A pretest was administered to establish baseline equivalence among the groups, after which the treatment lasted for five weeks. During the intervention period, students in the experimental groups were taught Ecology using Science Process Skills and Problem-Solving Skills instructional approaches respectively, while the control group received instruction through the traditional teaching method. At the end of the treatment, a posttest was administered, and the data collected were analyzed using Analysis of Covariance (ANCOVA) at the 0.05 level of significance.

Results

H_0: There will be no significant main effect of treatments on students' academic achievement in Ecology in Oyo East Local Government Area, Oyo State.

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Table 1: Tests of Between-Subjects Effects of Treatments on Students' Academic Achievement in Ecology in Oyo East Local Government Area, Oyo State

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	633.071[a]	3	211.024	39.547	0.000	0.563
Intercept	966.941	1	966.941	181.209	0.000	0.663
Pretest	2.637	1	2.637	0.494	0.484	0.005
Treatments	479.260	2	239.630	44.908	0.000	0.494
Error	490.918	92	5.336			
Total	54093.000	96				
Corrected Total	1123.990	95				

a. R Squared = 0.563 (Adjusted R Squared = 0.549)

Source: Researcher's Fieldwork, 2026

From Table 1, the Analysis of Covariance (ANCOVA) result on the main effect of treatments on students' academic achievement in Ecology in Oyo East Local Government Area, Oyo State was $F_{(2, 92)} = 44.908$, $p < 0.05$, partial $\eta^2 = 0.494$. The results clearly show that the effect of the treatments was statistically significant. Therefore, there is a significant main effect of treatments on students' academic achievement in Ecology in Oyo East Local Government Area, Oyo State. The large effect size further indicates that a substantial proportion of the variation in students' posttest achievement scores is attributable to the instructional treatments.

Table 2: Estimated Marginal Means of Treatments on Students' Academic Achievement in Ecology in Oyo East Local Government Area, Oyo State

Dependent Variable: Posttest

			95% Confidence Interval	
Treatments	Mean	Std. Error	Lower Bound	Upper Bound
Problem_Solving_Skills	23.658[a]	0.392	22.879	24.438
Science_Process_Skills	26.257[a]	0.417	25.430	27.084
Traditional_Teaching	20.017[a]	0.471	19.082	20.952

a. Covariates appearing in the model are evaluated at the following values: Pretest = 12.45.

Source: Researcher's Fieldwork, 2026

Table 2 presents the estimated marginal means of students' posttest achievement scores across the different instructional treatments after adjusting for pretest performance. When the pretest score was statistically controlled at 12.45 for all groups, students exposed to Science Process Skills instruction recorded the highest adjusted mean score of 26.26, followed by those taught using Problem-Solving Skills instruction with an adjusted mean score of 23.66, while students taught using the Traditional Teaching method obtained the lowest adjusted mean score of 20.02.

Although differences were observed in the adjusted mean scores across the three instructional groups, the associated confidence intervals show no overlap strong enough to suggest instability in the pattern of performance. Science Process Skills instruction (25.43 to 27.08) maintained consistently higher achievement estimates compared to Problem-Solving Skills instruction (22.88 to 24.44) and Traditional Teaching (19.08 to 20.95), indicating a clear pattern of better performance under the science process skills approach.

In practical terms, students taught using Science Process Skills instruction performed better in Ecology than those in the other groups, followed by Problem-Solving Skills instruction, while the Traditional Teaching group recorded the least performance. This pattern suggests that more interactive and learner-centred instructional strategies contributed more positively to students' understanding and achievement in Ecology.

In relation to the earlier ANCOVA findings, the adjusted mean scores reinforce the observed treatment effect by showing a consistent superiority of the experimental instructional approaches over the traditional method. Therefore, the evidence supports the conclusion that

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instructional treatments had a meaningful influence on students' academic achievement in Ecology in the study area.

Discussion of Findings

There was a significant main effect of treatments on students' academic achievement in Ecology. The findings revealed that students exposed to Science Process Skills and Problem-Solving Skills instructional approaches achieved significantly higher scores than those taught through the Traditional Teaching method. More specifically, Science Process Skills instruction produced the highest level of achievement, followed by Problem-Solving Skills instruction, while the Traditional Teaching approach recorded the lowest performance. This outcome suggests that instructional approaches that actively engage learners in scientific inquiry, observation, experimentation, analysis, and problem resolution are more effective in promoting meaningful understanding of ecological concepts than conventional teacher-centred methods.

The present finding is consistent with the study titled Impact of Inquiry-Based Instruction on Science Process Skills Acquisition in Ecology among Secondary School Students in Katsina State, Nigeria, which reported that students exposed to inquiry-based instruction demonstrated superior science process skills acquisition in ecology compared with those taught through the lecture method (Isa et al., 2025). The study emphasized that active participation in learning activities enhanced students' ability to investigate ecological phenomena and develop scientific reasoning. The similarity between the two studies may be attributed to the fact that both inquiry-based instruction and science process skills approaches encourage learners to construct knowledge through observation, experimentation, and critical thinking rather than passive reception of information.

The finding also agrees with the study titled Effect of Guided Discovery Strategy on Science Process Skills Acquisition and Academic Performance among Senior Secondary School Biology Students in Katsina State, Nigeria. The study found that students taught through guided discovery performed significantly better and acquired higher science process skills than those exposed to conventional teaching methods (Namani & Yusuf, 2025). Guided discovery, like science process skills instruction, places learners at the centre of the learning process and encourages active exploration of biological concepts. The superior performance recorded among students exposed to Science Process Skills instruction in the present study further reinforces the argument that learner-centred instructional approaches improve understanding and academic achievement in science-related subjects.

Similarly, the result aligns with the study titled Enhancing Secondary School Students' Science Process Skills through Guided Inquiry-Based Laboratory Activities in Biology. The study established that students who participated in guided inquiry-based laboratory activities demonstrated greater improvement in science process skills than those who received traditional laboratory instruction (Chengere et al., 2025). The researchers attributed the improvement to the opportunities provided for students to formulate hypotheses, conduct investigations, analyse results, and draw conclusions independently. This supports the current finding that students perform better academically when they are actively involved in the learning process rather than being limited to passive observation.

The present finding is further supported by the study titled Effectiveness of Inquiry-Based Learning in Enhancing Science Process Skills among Secondary School Students in Anambra State. The study reported substantial improvements in observing, hypothesizing, and data analysis skills among students exposed to inquiry-based learning compared with those taught using traditional approaches (Obienyem, 2025). The study also highlighted students' enthusiasm and active engagement as important factors contributing to improved learning outcomes. This corroborates the present result where students exposed to Science Process Skills instruction achieved the highest adjusted mean scores in Ecology.

The outcome of this study also finds support in the meta-analytic study titled The Relationship between Scientific Process Skills and Science Achievement: A Meta-Analysis Study. The review established a strong positive relationship between scientific process skills and students' achievement in science education across various studies (Dolapcioglu & Subasi, 2022). The synthesis of evidence indicated that learners who possess stronger science process skills tend to achieve better academic outcomes. This broad empirical evidence strengthens the present finding by demonstrating that the superior achievement observed among students taught through Science Process Skills instruction is consistent with wider trends in science education research.

The effectiveness of Problem-Solving Skills instruction observed in this study is equally supported by the study titled The Effects of Problem-Based Learning on Academic Achievement in Ecology Concepts among Science Education Students in Gusau. The study revealed that students taught ecology concepts through problem-based learning achieved significantly higher scores than those taught using conventional methods (Yahaya, 2023). The researchers concluded that engaging students in solving ecological problems enhanced understanding and promoted better academic performance. This finding corresponds with the present study where students exposed to Problem-Solving Skills instruction outperformed those in the Traditional Teaching group.

Further support comes from the study titled Effects of Paper-Based Problem Scenarios on High School Biological Problem-Solving Skills and Academic Achievement. The study found that students exposed to problem-based scenarios demonstrated higher academic achievement and stronger problem-solving abilities than students in the control group (Nigussie et al., 2025). Students also perceived the instructional approach as effective in developing their analytical and reasoning skills. This evidence reinforces the present finding that Problem-Solving Skills instruction

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contributes positively to students' achievement in Ecology by encouraging active engagement with real-life and contextual scientific challenges.

The finding is also consistent with the study titled Effects of Guided Discovery and Problem-Solving Instructional Strategies on Achievement and Retention of Biology Students in Delta Central Senatorial District, Nigeria. The study revealed that both guided discovery and problem-solving strategies produced better achievement outcomes than the lecture method, with guided discovery yielding the highest achievement scores (Egbes & Ajaja, 2023). Although guided discovery yielded the highest achievement scores, students exposed to problem-solving instruction still performed significantly better than those taught conventionally. This pattern closely mirrors the outcome of the present study, where Science Process Skills instruction ranked highest, followed by Problem-Solving Skills instruction, while Traditional Teaching recorded the least achievement.

Additional support is provided by the study titled The Relationship between Problem-Solving Skills and Student Academic Achievement: A Meta-Analysis in Education. The study established a strong positive relationship between students' problem-solving abilities and their academic achievement across diverse educational settings (Banawi et al., 2024). The review concluded that students who possess stronger problem-solving skills generally demonstrate better learning outcomes. This broad evidence further validates the superior achievement recorded among students taught through Problem-Solving Skills instruction in the present study.

The result is equally in agreement with the study titled An Escape Room-Based Computer-Supported Collaborative Learning Approach to Enhancing Students' Learning Achievement, Collaboration Awareness, Learning Motivation and Problem-Solving Skills. The study demonstrated that students exposed to an interactive, problem-oriented learning environment achieved higher levels of academic performance and problem-solving competence than those taught through traditional approaches (Chang et al., 2025). The findings suggest that instructional strategies which challenge learners to think critically, collaborate, and solve problems promote deeper learning and improved achievement. This observation supports the current finding that learner-centred approaches such as Science Process Skills and Problem-Solving Skills instruction are more effective than conventional teaching methods in improving students' achievement in Ecology.

Conclusion

Based on the results of this study, it was concluded that instructional treatments are the major determinant of senior secondary school students' academic achievement in Ecology in Oyo East Local Government Area, Oyo State. Students exposed to Science Process Skills instruction and Problem-Solving Skills instruction performed significantly better than those taught using the Traditional Teaching method, indicating the effectiveness of learner-centred instructional approaches in improving achievement. Overall, the study established that academic achievement in Ecology is mainly shaped by the quality of instructional strategy employed, while gender plays a negligible role in influencing students' outcomes.

Recommendation

Based on the findings of this study, the recommendation was made:

Teachers of Ecology should prioritize the use of Science Process Skills instruction and Problem-Solving Skills strategies in classroom teaching to enhance students' understanding and academic achievement, as these approaches have been shown to be more effective than traditional methods.

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