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EFFECT OF INQUIRY-BASED LEARNING (IBL) ON STUDENT'S ACADEMIC ACHIEVEMENT IN ECOLOGY CONCEPTS IN GUMEL EDUCATION ZONE JIGAWA STATE, NIGERIA

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Abstract

*This study examined the effect of Inquiry-Based Learning (IBL) on students' academic achievement in Ecology concepts in Gumel Education Zone, Jigawa State, Nigeria. A quasi-experimental pretest and posttest control-group design was adopted. The study involved 146 SS II Biology students from two public co-educational secondary schools. Data were collected using the 30-item Ecology Achievement Test (EAT) and analysed using mean, standard deviation, and Analysis of Covariance (ANCOVA) at the 0.05 significance level. The findings revealed that students taught using IBL achieved significantly higher scores than those taught using the conventional method (*F *= 20.206,* p*< 0.001). Female students also achieved significantly higher scores than male students taught using IBL (*F *= 6.463,* p *= 0.013). The study concluded that IBL improves students' academic achievement in Ecology concepts. It recommended that Biology teachers incorporate IBL into their teaching practices to enhance students' academic achievement and active participation.*

Keywords: *Inquiry-Based Learning, academic achievement, Ecology, Biology students, gender.*

Introduction

The global aim of science is to enable learners acquire knowledge and skills that would be relevant to their future livelihoods (Gali, 2018). Science, as a concept, is a process geared towards problem solving in order to enhance the living standard of man. Shaibu (2016) defines science as a complex human activity that lead to the production of a body of universal statement called laws, theories or hypotheses, which serve to explain the observable behaviour of the universe or part of it, which, in themselves, have predictive characteristics. Sanusi (2019) has observed that the economic and political strength of a nation is always assessed in terms of achievements in science and technology. In fact, Usman (2021) posits that people live in a world where science and technology have become integral parts of human culture and any country that overlooks this significant truism does so at the risk of remaining backward in an advancing world. The National Policy on Education (FRN, 2015) sets a goal for science education in Nigeria that government shall popularize the study of science and production of adequate number of scientists to inspire and support national development. Based on this policy, Omiko (2015) deduced that the aim of science education is to inculcate science in the thinking and working processes of the society in order to create science and technology culture. Science Subjects offered in the Nigerian Senior Secondary Schools as recognized by West African Examination Council (WAEC) and the National Examinations Council (NECO) in their Chief Examiners Reports include Biology, Physics, Chemistry, Agricultural Science, Physical Education and Health Education.

Biology is a fundamental science subject that enables students to understand life processes and environmental interactions. Within Biology, ecology is particularly important because it deals with the relationships between organisms and their environment. A sound understanding of ecology equips students with knowledge necessary for environmental conservation and sustainable development. Abubakar (2017) have observed that Biology, as a discipline, has contributed tremendously to financial, physical and aesthetic benefits of humanity and to national building. The areas of contributions of Biology include but not limited to, the followings: Medicine, Aquaculture, Crime detection, Forestry, Genetic Engineering, Parasitology, Biotechnology Physiology, Ecology, Genetics, Microbiology, Biotechnology, and Molecular Biology has made Biology subject to become a central focus in most human activities including solutions to the problem of food security, environmental pollution, population explosion, radiation, disease, health, hygiene, family life, poverty eradication, management and conservation of natural resources as well as Biotechnology and ethics. The objectives of learning Biology at senior secondary school level include learners having adequate laboratory and field skills in Biology in general and ecology in particular.

Obeka (2018) stated that ecology is concerned with the Biology of groups of organisms with functional process on land in the oceans and in freshwater. Ecology deals with the interaction of organisms and their natural environment and needs to be taught with an appropriate method or strategy of teaching that requires direct observation of organisms in natural habitat. These organisms may be within or far away from the school environment. Danjuma (2017) observed that teaching ecology at secondary schools in Nigeria has not been very impressive due to poor teaching instructional strategies used. Gali (2018) stated that the poor teaching strategies employed by a number of teachers affect the performance of the students in the subject. Dallatu (2019) observed that teaching Biology using teacher centered strategies such as lecture method does not encourage the learners to participate fully in the classroom activities and hence students perform poorly in Biology concept

Despite its importance, students' academic achievement in ecology concepts in Nigerian secondary schools has remained unsatisfactory. Reports from examining bodies such as the West African Examinations Council consistently indicate poor performance in Biology, especially in ecology-related topics.

One major factor contributing to this problem is the persistent use of conventional lecture methods, where students are passive recipients of information. This method often fails to promote deep understanding or long-term retention (Akinbobola, 2015).

In contrast, Inquiry-Based Learning (IBL) is a student-centered instructional approach that encourages learners to actively participate in the learning process by asking questions, investigating problems, and constructing knowledge. IBL is rooted in the constructivist theory proposed by Jean Piaget, which emphasizes active learning through experience.

Therefore, Empirical studies have shown that IBL improves students' academic performance. For instance, Achor and Orji (2015), Igbogoro (2018), Simpkins (2018) found that students taught Biology using inquiry methods performed significantly better than those taught using lecture methods. However, most of these studies were conducted outside Jigawa State, and little is known about the effectiveness of IBL in teaching ecology concepts within Gumel Education Zone. This creates a gap that this study seeks to address.

Statement of the Problem

Students in Gumel Education Zone continue to exhibit poor academic achievement and low in ecology concepts. This problem may be linked to the dominance of teacher-centered instructional methods. Poor performance in Biology among Nigerian secondary school students has been the major concern of parents, teachers and the public. Jibrin and Nura (2017) have identified poor methods of teaching and improper use of instructional materials as some of the deficiencies of Biology teachers, which has led to low academic performance on the part of the students. Despite its importance, Biology teaching in the senior secondary schools is the best foundation be laid for the students, certain problems negatively affect its teaching Musa (2017). This might be responsible for the poor performance noticed in the WAEC and NECO result. One of the major purposes of Biology programme in Nigeria secondary schools is to enable students to apply it to everyday life activities. Unfortunately, this purpose has not been achievable due to poor performance of students as reported by Chief examiners of WAEC as recorded in Table 1.

Table 1: Performance of students in Biology at SSCE level from (2021-2025)

Year	No of Students Present	No of Students Pass	% Pass	No of Students Fail	% fail	Total
2021	228953	80355	35	148598	65	100
2022	250099	86150	34	163949	66	100
2023	289520	84520	21	205000	79	100
2024	326541	98215	30	228326	70	100
2025	367562	120560	33	247002	67	100

Source: West African Examination council 2021/2025 Annual Report**.**

In view of this, this study seeks to investigate the effects of Inquiry-based learning on students' academic achievement in ecology concepts in Gumel Education Zone, Jigawa State, Nigeria.

Objective of the Study

Specifically, the study aims to:

i. Determine the difference between the mean academic achievement scores of SS II Biology students taught Ecology concepts using Inquiry-Based Learning and those taught using the conventional teaching method.
ii. Find out the difference between the mean academic achievement scores of male and female SS II Biology students taught Ecology concepts using Inquiry-Based Learning.

Research Questions

The following research questions are set to guide the study;

i. What is the difference between the mean academic achievement scores of SS II Biology students taught Ecology concepts using Inquiry-Based Learning and those taught using the conventional teaching method?
ii. What is the difference between the mean academic achievement scores of male and female SS II Biology students taught Ecology concepts using Inquiry-Based Learning?

Research Hypotheses

Following null hypotheses were formulating and testing at the significant level of 0.05

H_{01}: There is no significant difference between the mean academic achievement scores of SS II Biology students taught Ecology concepts using Inquiry-Based Learning and those taught using the conventional teaching method.

H_{02}: There is no significant difference between the mean academic achievement scores of male and female SS II Biology students taught Ecology concepts using Inquiry-Based Learning.

Research Design

A quasi-experimental design (pretest and posttest control group) was used. Both the experimental and control groups were pre-tested to ensure group equality, thereafter the students would exposed to treatment for 6 weeks; post-test was administered to determine students' academic achievement.

Population of the Study

The population of the study comprised of 2739 SS II Biology students in public co-educational senior secondary schools in Gumel Educational Zone which comprised of 1523 males and 1216 females with an average age of 17 years. According to Zonal Education Quality Assurance unit, there are thirty-three (33) co-educational public secondary schools in Gumel Educational Zone that are offering Biology.

Sample and Sampling Technique

The sample for the study comprised 146 SS II Biology students drawn from a population of 2,739 students in 33 co-educational secondary schools in Gumel Education Zone, Jigawa State. The sample consisted of 58 males and 88 females, with 75 students (30 males and 45 females) in the experimental group and 71 students (28 males and 43 females) in the control group. A simple random sampling technique using balloting was employed to select two schools from the 33 eligible co-educational secondary schools. The selected schools were then randomly assigned to the experimental and control groups, with School C assigned to the experimental group and School K to the control group. One intact SS II Biology class was subsequently selected by balloting from each school to participate in the study. The experimental group was taught selected Ecology concepts using Inquiry-Based Learning (IBL), while the control group was taught the same concepts using the conventional teaching method. Both groups received instruction for the same period and were assessed using the same research instrument. The inclusion of male and female students in both groups provided an opportunity to examine the interaction effect of teaching method and gender on students' academic achievement in Ecology concepts.

Table 2: List of Sampled Schools and Number of SS II Biology Students

S/N Name of School	Male	Female	Total
1. School C (Experimental Group)	30	45	75
2. School K (Control Group)	28	43	71
Total	58	88	146

Instrumentation

The instrument used for data collection was the Ecology Achievement Test (EAT), developed by the researcher and adapted from relevant West African Senior School Certificate Examination (WASSCE) questions from 2021 to 2025. The instrument consisted of two sections: Section A collected students' personal information, while Section B contained 30 multiple-choice questions on the selected Ecology concepts. Each question had four options (A–D), with one mark awarded for each correct answer, giving a maximum score of 30 marks. The EAT was administered as both a pre-test and a post-test to determine students' academic achievement before and after the instructional intervention. Data collected were analysed using the Statistical Package for the Social Sciences (SPSS), version 20.0. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the research hypotheses at the 0.05 level of significance.

Results

The results are presented in tables in line with the research questions raised, and the corresponding formulated hypothesis.

Research Question One: What is the difference between the mean academic achievement scos of SS II Biology students taught Ecology concepts using Inquiry-Based Learning and those taught using the conventional teaching method?

The descriptive statistics in form of mean and standard deviation was used to answer question one and it is presented in table 3.

Table 3: Mean achievement scores of biology students taught cell Biology using inquiry-based learning and conventional methods.

Group	N	Mean (X)	S.D	M.D	Std Error Mean
Control	71	22.29	4.37	1.88	.51
Experimental	75	26.01	2.96		.34

From table 3, the students taught using conventional method of teaching has the mean achievement score of 22.29 and the standard deviation of 4.37, while those exposed to inquiry-based learning has the mean score of 26.01 and the standard deviation of 2.96 The mean difference for the group is 1.88, so this clearly shows that there is significant difference between their achievements and that the students taught using inquiry-based learning have high mean achievement scores than those using conventional method.

Hypothesis One: There is no significant difference between the mean academic achievement scores of SS II Biology students taught Ecology concepts using Inquiry-Based Learning and those taught using the conventional teaching method.

Table 4: ANCOVA test for the posttest achievement scores of biology students taught using inquiry-based learning and those taught using conventional method of teaching.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	582.814[a]	2	291.407	21.806	.000	.234
Intercept	2217.197	1	2217.197	165.911	.000	.537
Pretest	78.753	1	78.753	5.893	.016	.040
Group	270.028	1	270.028	20.206	.000	.124
Error	1911.022	143	13.364			
Total	88036.000	146				
Corrected Total	2493.836	145				

a. R Squared = .234 (Adjusted R Squared = .223)

Table 4 reveals the ANCOVA analyses for post-test mean achievement scores of control and experimental groups (those taught using inquiry-based learning), the F calculated value variable (achievement) is 20.206 with the significant F at 0.000 which is less than 0.05 therefore, and the null hypothesis is hereby rejected because the observed p-value is less than the significant level p-value (0.05). Hence, there is significant difference between the mean achievement scores of secondary school biology students taught using inquiry-based learning and those taught using conventional method of teaching. (F-Cal = 20.206, p=0.000<0.05).

Research Question Two: What is the difference between the mean academic achievement scores of male and female SS II Biology students taught Ecology concepts using Inquiry-Based Learning?

The descriptive statistics in form of mean and standard deviation was used to answer question two and it is presented in table 5

Table 5: Mean achievement scores of male and female biology students taught Ecology concepts using inquiry-based learning.

Group	N	Mean (X)	S.D	M.D	Std Error Mean
Male	30	24.33	3.49	2.09	.63
Female	45	26.42	3.12		.46

From table 5, the male students taught using inquiry-based learning has the mean achievement score of 24.33 and the standard deviation of 3.49, while the female students have the mean scores of 26.42 and the standard deviation of 3.12 The mean difference for the group is 2.09, However, this clearly shows that there is significant difference between the two groups in favour of the female students having the higher scores than their male counterpart.

Hypothesis Two: There is no significant difference between the mean academic achievement scores of male and female SS II Biology students taught Ecology concepts using Inquiry-Based Learning.

Table 6: ANCOVA test for the posttest achievement scores of male and female biology student taught using inquiry-based learning.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	78.545[a]	2	39.273	3.608	.032	.091
Intercept	1655.400	1	1655.400	152.096	.000	.679
Pretest_Gender	.003	1	.003	.000	.987	.000
Gender	70.344	1	70.344	6.463	.013	.082
Error	783.641	72	10.884			
Total	49963.000	75				
Corrected Total	862.187	74				

a. R Squared = .091 (Adjusted R Squared = .066)

Table 6, revealed the ANCOVA analyses for post-test mean achievement scores of male and female biology students taught Ecology concepts using inquiry-based learning, the F calculated value variable (gender) is 6.463 with the significant F at 0.013 which is less than 0.05 Therefore, the null hypothesis is hereby rejected because the observed p-value is less than the significant level p-value (0.05). Hence, there is significant difference in the mean achievement score of male and female biology student taught using inquiry-based learning, in favour of the female students (f-cal = 6.463, p=0.013<0.05).

Discussion of Findings

This study aimed at determining the effect Inquiry-Based Learning (IBL) on Students' Academic Achievement in Ecology Concepts in Gumel Education Zone, Jigawa State two (2) research questions were raised and two (2) hypotheses were tested and the results from analysis were presented. The first result of findings revealed significant difference between the mean achievement scores of students taught using inquiry-based learning and those taught using conventional method in favor of experimental group. The result of the ANCOVA test result on the mean academic achievement scores of Senior Secondary School students exposed to inquiry-based learning on ecology concepts and those taught with conventional method revealed a significant difference in favor of students taught with inquiry-based

learning (experimental group).This implies that exposing students to inquiry-based instructional strategy enable them to have higher academic achievement in Ecology concepts more easily than those exposed to Conventional Method.

The finding agreed with the earlier findings of Danjuma (2017) and Achor (2015). Similarly, the finding is in line with the studies of Omiko (2015) who investigated the effect of Inquiry method on students' achievement in Biology in secondary schools in Enugu Education Zone, Nigeria and found that the students that were taught Biology using Inquiry-based instructional strategy achieved better and had higher interest score than their counterparts taught with the Conventional method.

The findings also is in line with the studies of Abdul (2020), Muhammad (2020), Adamu (2021) who in their study reported that, inquiry-based teaching strategy improve academic achievement toward teaching biology.

On contrary, Iwuju (2020) investigated the effect of Activity based teaching strategy (ABTS) on academic achievement in basic science among junior secondary students in Kastina. The findings revealed that, there was no significance difference in the academic achievement of students taught using activity based teaching strategy and those taught lecture method.

Similarly, the findings disagree with findings of Maikano (2017) investigated the effects of ecological concepts using the outdoor laboratory instructional strategy on students' academic performance in the North East Nigeria. The findings of the study revealed that there was no significant difference in the academic performance taught students ecological concepts using the outdoor laboratory instructional strategy.

The second findings showed significant difference between the mean achievement scores of male and female students taught using inquiry-based learning. The result of ANCOVA test at $P< 0.05$ revealed that there is significant difference in the achievement of male and female students exposed to inquiry-based learning.The female students have a higher academic achievement than the male students. The findings showed that female had a higher achievement when taught with inquiry-based learning.

This finding is in line with the Achor and Omiko (2015) revealed that the achievement of female students was higher than that of the male students. The result also revealed better performance in favor of female students compared to their male counterparts using this method.

The finding agreed with the Yusuf (2019) in his research titled comparative study of gender difference in achievements in geography concluded that female students with very good results are more than that of the male students.

Similarly, the finding is in line with the study of Shittu (2012) in his study on the effect of guided inquiry strategy on the academic performance and attitude of low achievers in physics. It concluded that the level of performance of male low achievers exposed to guided inquiry strategy is the same with their female counterparts.

On contrary, the findings disagreed with the studies of Igbogoro (2018),Erinoso (2015) and Simpkins (2016) who investigated the effect of inquiry based strategy on the

academic achievement and found that, there were no significance difference in the mean achievement scores of male and female students taught with inquiry approach.

The findings is also in contrary with the studies of Uhmuavbi, Oriahi and Olusi (2013) and Appaw, and Njoku, (2017) who revealed that boy's perform better than girl's in science, Technical, and mathematics subject when taught students using inquiry-based learning as a teaching method also pointed out that the male students scored significantly higher than the females.

In view of the different research works reviewed, majority of them revealed that there is gender difference in academic achievement when inquiry-based teaching strategy were used as method of instruction. This implies that inquiry-based teaching strategy are gender difference Thus, the innovative teaching strategy has been found to be good strategy for teaching/learning of awkward topic like Ecology concepts and other Biology topics.

Conclusion

The following conclusions were drawn from the findings of the study:

i Inquiry-based learning (IBL) improves biology students' academic achievement in ecology concepts than the conventional method of teaching.
ii Female biology students' academic achievement in ecology concepts is higher than their male counterparts when taught using inquiry-based learning.

Contributions to Knowledge

The findings of this study made the following contributions to knowledge:

i The study established that Inquiry-Based Learning (IBL) significantly improves students' academic achievement in Ecology compared with the conventional teaching method ($F=20.206$, $p<0.05$).
ii The study revealed a statistically significant difference in the academic achievement of male and female students taught using IBL, with female students achieving higher scores than their male counterparts ($F=6.463$, $p=0.013$).

Recommendations from the Study

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

i The Ministry of Education, curriculum planners, and relevant professional bodies should encourage and support the integration of Inquiry-Based Learning (IBL) into Biology teaching in senior secondary schools to promote active student participation and improve academic achievement.
ii Biology and other science teachers should adopt gender-responsive instructional practices when implementing IBL to address differences in students' academic achievement and ensure equitable learning opportunities for both male and female students.

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