

EFFECTS OF INQUIRY-BASED LEARNING ON STUDENTS' RETENTION IN SENIOR SECONDARY SCHOOL BIOLOGY

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Abstract

This study investigated the effects of inquiry based learning on students' retention in senior secondary school biology. Two research question guided the study. A quasi experimental research design was adopted. 216 SSS2 biology students in Ikwo Local Government Area of Ebonyi State, South East of Nigeria were used in the study. Data were collected using Biology Retention Test (BRT) validated by experts in Biology Education and Measurement and Evaluation BRT had reliability index of 0.92 as determined using kuder-Richardson formula 20 (K-R 20) reliability coefficient. Findings of the study revealed that inquiry based learning has positive effects on students' retention in biology. Again, inquiry based learning favours female students' retention in biology than the male students Recommendations made include, teachers should adopt the inquiry based learning method to teach students. Also training and re-training of teachers in the use of inquiry based teaching should be organized for teachers by professional bodies such as the Science Teachers Association of Nigeria and the Ministry of Education. Key Words: Inquiry Based learning, Retention, Biology, Senior Secondary School

Introduction

Biology is the study of living things, from microscopic to macroscopic, their relationships and interactions with other living things and the environment, as well as the metabolic processes they engage in (Afolabi & Audu, 2017) penned that Biology is a science of life that plays a vital role in the life of every human being. Biology is vast and has many divisions including zoology, botany, ecology, genetics, morphology, anatomy, physiology, histology, microbiology, biochemistry, evolution, cell biology, molecular biology, among others (Ezekiel, Yilshik & Joseph, 2021). Biology has vast applications in such fields such as medicine, pharmacy, food production and genetic engineering (McDowell, 2021); its importance in national economic development cannot be overemphasized. Hence, the Federal Government of Nigeria in the National Policy on Education adopted biology as one of the core subjects in senior secondary school in Nigeria (FGN, 2009). Despite the high rating of biology by the government among school subjects, students do not perform well in internal and external examinations in biology (Ahmed, 2008; Ezekiel, Yilshik & Joseph, 2021).

Students' performance in biology at the Senior School Certificate Examination has been unsatisfactory over the years (WAEC Chief Examiner's Report, 2018, 2019, 2020). Poor performance in biology is an indication of poor retention in biology.

Knowledge retention is the proportion of the new information transferred into the long-term memory that an individual retains over a certain period (Udu, 2017; Dovepress, 2021). In line with the above, retention is the act of remembering or recalling what has been learnt or experienced in the past (Adonu et al, 2021). Retention of knowledge is important for good academic achievement, especially in the sciences and biology in particular (Haqie, 2021). Probably, if what has been learnt is retained, it may lead to higher achievement because retention is measured in

collaboration with achievement (Iji, 2010). Researchers such as Ogbonna (2007), Okereke (2006), and Adonu et al (2021) view retention as an important factor in enhancing students' achievement. Poor retention and poor performance could be a result of ineffective teaching strategy/method used by the teacher (Igboanugo, 2024).

Learners face many difficulties in learning science subjects, particularly biology, in our schools (Ugwu, Jatau & Gwamna, 2020; Udu et al., 2020). Teachers' use of effective teaching/learning strategies that will actively engage the learners in the learning processes would help students to overcome such difficulties (Ishaku, 2019). Teaching/Learning strategies contribute significantly to how students retain concepts they have been taught in biology, and consequently, to their academic achievements. Several teaching methods have been adopted to teach biology, including the lecture/expository approach, demonstration, discovery, discussion, flipped classroom, inquiry based learning (Osemwiyen, 2009; Mwenda and Ndayambaje, 2021). Some of the teaching methods are becoming ineffective and yield poor outcomes because they place a greater emphasis on information transfer through memorization (Ibe & Nwosu, 2003; Udu, 2020). The lecture method, for instance, poses the teacher as one who transfers knowledge to the students, making the students passive in the learning process. This shortcoming, among others, resulted in the continual search by researchers for innovative ways to ensure effective teaching and learning. One of the innovative strategies suggested is inquiry-based learning based on the constructivist theory, among others (Igboanugo & Naiho, 2024).

Inquiry-Based Learning (IBL) is a constructivist approach to learning. It enables the learner to construct concepts from experience and from verbal interaction (Enebechi, 2021). Knowledge construction occurs through active thinking of the learner (Cakir, 2008). Inquiry-based learning is a strategy that attempts to help learners ask questions and discover answers to their questions. Inquiry methods permit observing an event, recognizing relevant and irrelevant questions, searching out data, and taking complete responsibility for the entire process of obtaining, organizing, and interpreting data (Oghenevwede, 2010). Inquiry-based learning is a kind of approach to learning that focuses on the involvement of students in their search for learning (Belo, 2021). Based on studies conducted, inquiry-based learning leads to better engagement among students throughout a class period and provides a greater grasp and understanding of the content knowledge, and creates an atmosphere of overall engagement and interest (Wheatley, 2018). This conforms to Igboanugo (2023), who maintained that an effective mode of instruction should appeal to the learner's interest. Students who were instructed through inquiry-based learning achieved higher scores than those who were instructed through the traditional method (Ali, 2014). Scholl (2023), in agreement with the above, noted that some of the advantages of inquiry-based learning include that it encourages critical thinking, improves problem-solving skills, encourages creativity, encourages engaged learning, connects learning to the real world, and promotes knowledge retention. However, the inquiry-based learning method is not without its challenges. According to Lee (2023), some of the concerns of inquiry-based learning include that it is timeconsuming, and students may be reluctant to participate. Furthermore, students may face the problem of a lack of confidence, among others. Gender could influence educational productivity and outcomes (Igboanugo, 2024).

Gender is a psychological term used to describe behaviours and attributes expected of individuals on the basis of being either male or female (Ozioko, 2015). There have been a lot of arguments on the effect of gender on the academic performance of students in science. Salihu (2015) reported that male students perform better than females in Ecology. On the contrary, Sukola,

Abdumalik & Yunusa (2016) revealed that female students perform better in biology than their male counterparts. However, Onyejekwe, Uchendu & Nmomo (2018) showed that gender has no significant effect on students' performance in Biology. From the foregoing, there have been contradictory reports on the influence of gender on the academic performance of students in biology.

While several innovative instructional methods have been suggested for teaching the sciences, the effectiveness of these contemporary instructional methods ought to be considered also. Thus, this study considers the effects of inquiry-based learning on students' retention in senior secondary school biology

Purpose of the Study

This study seeks to find out the effects of inquiry-based learning on students' retention in biology in secondary schools. In more specific terms, the study seeks to determine:

1. The effects of inquiry-based learning on students' retention in biology.
2. The effects of inquiry-based learning on male and female students' retention in biology.

Research Questions

The study seeks to answer the following research questions:

1. What is the mean retention score of students taught biology using inquiry-based learning and those taught using the lecture method?
2. What are the effects of inquiry-based learning on male and female students' retention in biology?

METHODOLOGY

The study adopted a quasi-experimental design, precisely the non-randomized, pre-test, posttest, control group design. This design was adopted because it was not possible to have complete randomization of the subjects, as that would have disrupted school organization. Hence, intact classes were randomly assigned to experimental and control groups. The schematic design of this study is shown below:

A	T1	X1	T2
B	T1	X0	T2

Where:

A = Experimental group

B = Control group

T1 = Administration of Pre-Achievement Test (pre-test)

X1= Treatment for the experimental groups (inquiry-based learning)

X0= Absence of treatment for the control group (lecture)

T2 = Administration of Post-Achievement Test (post-test)

Population of the Study

All the 7212 (3019 males, and 4193 females) SSS2 biology students in the 2022/2023 academic session in government-owned secondary schools in Ikwo Local Government Area of Ebonyi State, Nigeria, form the population of the study. The SSS2 students were considered appropriate for the study because they had studied biology for at least one year at the senior secondary school level and had decided to study Biology further. Public schools were chosen because they are under the same authority and control by the State Education Board. The biology content covered is the classification of plants as stipulated in the SSS 2 biology curriculum (FMN, 2019).

A sample of 216 students was used for the study. A simple random sampling technique was used to select four (4) schools out of the 23 public secondary schools in Ikwo Local Government Area. Two of the schools were randomly assigned to the experimental group, while the remaining two were assigned to the control group. The experimental group was made up of 96 students (42 males and 54 females), while the control group was made up of 120 students (53 males and 67 females).

Each of the schools sampled has one SS 2 biology class; therefore, only one teaching strategy was used per school.

Instruments for Data Collection

The instrument used in this study was the Biology Retention Test (BRT). BRT was a researcher-made instrument that contained two sections. Section A contained bio-data information of the students, while Section B contains 20 items, 4 options, a multiple-choice objective test which students were expected to respond to by choosing from options A-D, with one of the options being the key, while the other options are distractors. The items of BRT covered the classification of plants, drawn from the Biology SS II scheme of work. BRT was developed based on the test blueprint/table of specifications. The test blueprint is used to ensure the content validity of BRT. Also, two lesson plans, one for the experimental group and one for the control group, were written by the researcher. The lesson plan for the experimental group was developed based on the use of the inquiry method to teach classification of plants, while the lesson plan for the control group was developed based on the use of the lecture method to teach classification of plants. The Biology Retention Test (BRT) was face validated by two experts in Biology education from the Department of Science Education, and one expert in Measurement and Evaluation in the Department of Educational Foundation, both in Alex-Ekwueme Federal University, Ndufu Alike, Ebonyi State. Corrections and suggestions arising from these experts were used to review the BRT. The lesson plans were also validated by the two Biology Education experts and one secondary school Biology teacher. The experts considered the following: conformity of the lesson plans to the principles of inquiry-based learning, the extent to which lesson plans covered classification of plants, appropriateness of language, and appropriateness of the features of the lesson plan. After this review, all 20 items of BRT sailed through.

Biology Retention Test (BRT) was trial-tested by administering it to 30 SS II students from a senior secondary school that was outside of the area of the study. The data obtained was used to determine the internal consistency of the BRT, using the Kuder-Richardson formula 20 (K-R 20). The consistency was found to be 0.92, which is appropriate.

Experimental Procedure

The regular teachers of the sample schools were used to teach the students for this study. The conduct of the study took place during the normal school lesson periods. Before the commencement of the actual treatment, the researcher trained the regular teachers from the experimental group for four (4) days. The training covered the following areas: 1. Features and use of the inquiry method to teach classification of plants. 2. The purpose of the research; 3. The Biology concepts to be taught; 4. Procedure for administering the instrument.

The training was to ensure homogeneity of instructional situation in schools used for the experiment and the teacher's inclination to the use of the inquiry method. The experimental groups were taught by the regular teachers using an inquiry-based learning method, while the control group was taught using a lecture method.

Before the experiment, a pre-test was given to the participants in both groups using BRT, marked, and recorded. The experiment lasted for three (3) weeks. At the end of the experiment, the BRT was reshuffled, and a post-test was administered to the participants of both experimental and control groups, and the results were recorded. Another post-test was administered after 4 weeks to obtain the delayed test score.

The scores obtained from the pre- and post-tests were analyzed using SPSS version 22.0. Mean and standard deviation were used to answer the research questions.

Results of the study

The results are presented in tables 1 and 2 according to the research questions that guided the study.

Research Question 1: What is the mean retention score of students taught Biology using inquiry-based learning and those taught using the lecture method?

Table 1: Mean and Standard deviation of pre-test and post-test retention mean scores of students taught biology with inquiry-based and lecture methods.

Teaching Method	N	Pre-Test		Post-Test		Delayed Test		% mean retention
		Mean	SD	Mean	SD	Mean	SD	
Inquiry	9	9.51	5.38	57.63	8.75	42.51	7.9	73.76
Lecture	6		41.79	6.48	25.50	5.10	61.01	

Results in Table 1 show that the group taught biology using inquiry based learning method had a pre-test retention mean of 9.51 with a standard deviation of 5.38 and a post-test retention mean of 57.63 with a standard deviation of 8.75. The delayed test for the inquiry based group had a retention mean of 42.51 and standard deviation of 7.9, producing percentage mean retention of 73.76 for the experimental group. The group taught with lecture method of teaching had a pretest retention mean of 9.38 with a standard deviation of 5.13 and a post-test retention mean of 41.79 with a standard deviation of 6.48. The delayed test for the control group produced a retention mean of 25.50 and standard deviation of 5.10; with percentage mean retention of 61.01. However for each group, the post-test mean was greater than the pre-test mean with the group taught with inquiry based learning method of teaching having a higher mean gain. The percentage mean retention for the experimental group was also higher than that of the control group. This is an indication that the inquiry based learning method of teaching has more positive effects on students' retention in biology than lecture method.

Research Question 2: What are the effects of inquiry based learning on male and female students' retention in Biology?

Table 2: Mean and Standard deviation of pre-test and post-test on the effects of inquiry based learning on male and female students' retention in Biology.

Variable			Pre-Test		Post-Test		Delayed Test		% mean retention
Teaching Method	Gender	N	Mean	SD	Mean	SD	Mean	SD	$(\frac{mdt}{mpt} \times 100)$
Inquiry-Based Method	Male	42	9.16	4.54	48.57	6.02	30.82	6.08	63.59
	Female	54	9.35	5.84	46.87	7.73	30.80	7.82	65.71
Lecture Method	Male	53	8.14	4.47	40.77	5.07	18.15	4.46	44.51
	Female	67	8.24	5.66	40.02	6.41	17.45	5.64	43.60

Results in Table 2 shows the effects of inquiry based learning on male and female students' retention in biology. Result showed that the male group taught with inquiry based learning method had a pre-test retention mean of 9.16 and a post-test retention mean of 48.57. The delayed test for the male group taught with inquiry method produced a mean score of 30.82 and standard deviation of 6.08; with percentage mean retention of 63.59. The female group taught using inquiry based learning method had a pre-test retention mean of 9.35 and a post-test retention mean of 46.87. The delayed test for the female group taught with inquiry method produced a mean score of 30.80 and standard deviation of 7.82; with percentage mean retention of 65.71. Results in table 2 also show that the male group taught using lecture method had a pre-test retention mean of 8.14 and a post-test retention mean of 40.77. The delayed test for the male group taught with lecture method produced a mean score of 18.15 and standard deviation of 4.46; with percentage mean retention of 44.51. The female group taught using the lecture method had a pre-test retention mean of 8.24 and a post-test retention mean of 40.02. The delayed test for the female group taught with lecture method produced a mean score of 17.45 and standard deviation of 5.64; with percentage mean retention of 43.60. The female students have higher than the male students in both inquiry based and lecture methods; reflecting a better retention among the female students.

Discussion of Findings

The findings of this study reveal that the inquiry based learning method had more positive effect on students' retention in Biology than the lecture method. This is in line with the findings of Enebechi (2021) which revealed that the inquiry based learning approach is more effective than the conventional approach in enhancing students' retention in Biology. The finding is also in line with that of Ali (2014) who found that students taught with the inquiry based learning approach achieved higher than those instructed with the traditional method. This finding coincides with that of Mwenda (2021) which revealed that students taught through inquiry based teaching performed better than those taught through conventional methods. However, this finding disagrees with that of Oghenevwekede (2016) who found that the inquiry method was inferior and less effective than the discovery teaching method.

The findings of the study further revealed that the inquiry based learning method appeared to be more effective on the female students' retention in biology than their male counterparts by having high percentage retention mean score. The finding revealed that the inquiry based learning method improves female students' retention in biology more than the male students as females demonstrated a higher percentage retention mean score. This disagrees with the findings of

Enebechi (2021) which revealed that the inquiry based learning approach enhances gender parity as it concerned students' retention in biology.

Recommendations

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

Teachers should adopt the inquiry based learning method to teach students as it has proven more effective than the conventional lecture method in helping students' retention. The adoption of the inquiry based learning method by teachers will also make class time more conducive and interactive.

Also, regular sensitization, training and re-training should be organized by professional bodies such as the Science Teachers Association of Nigeria (STAN) to educate biology teachers on the use of the inquiry based learning method of instruction.

Finally, in planning the curriculum, curriculum planners should suggest activities that are inquiry based learning friendly in order to assist teachers.

Conclusion

This study investigated effects of inquiry based learning on students' retention in senior secondary school biology. Inquiry based learning method of teaching had more effect on students' retention in biology than the lecture method as shown by the findings of this study. The inquiry based learning method appeared to be more effective on the female students than it is on male students. The findings of this study have provided empirical evidence for the use of inquiry based learning strategy in biology teaching for improved retention and outcomes. It has some implications for students, biology teachers, researchers, as well as curriculum planners. Recommendations made if implemented would help to alleviate poor students' poor retention and performance in biology.

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