



Science Learning Performance and Retention of Biology Concepts among Secondary Students

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ARTICLE INFO

E-ISSN: 2721-0804
P-ISSN: 2723-6838
Vol. 3, No. 1, June 2021
URL: <http://usnsj.com/index.php/biology>

Suggestion for the Citation and Bibliography

Citation in Text:

Adebisi, R.O., Adeyemi, M.I., & Ubugadu M.A. (2021)

Bibliography:

Adebisi, R.O., Adeyemi, M.I., and Ubugadu M.A. (2021). Science Learning Performance and Retention of Biology Concepts among Secondary Students. *Journal of Biological Science and Education*, 3(1), 22-30.

Abstract

This study investigated the effects of science learning materials on performance and retention of biology concepts among senior high school students in Afijio local government of Oyo State, Nigeria. The study was Quasi-experimental involving pretest, posttest equivalent group design. In this design, 40 students were randomly selected from Senior High School Students 2, pretested to ascertain their group equivalence, and then divided into two groups (experimental and control) using the lottery method of sampling techniques. The experimental group was taught biology concepts with science learning materials, while the control group was taught the same concepts without science learning materials for three weeks. The two groups were pretested and post-tested for performance and retention, respectively. The data collected were analyzed using a simple percentage method, mean, and standard deviation. Based on the data generated and results obtained from the experiment, the findings revealed that the use of science learning materials in the teaching of Biology concepts significantly enhances student's retention ability and further improves the academic performance of the senior high school students. Moreover, students who are exposed to science learning materials in teaching biology concepts generally have better academic performance and retention ability than students who were not exposed to the given intervention. The study recommends that the Ministry of Education may consider to provide science learning materials for effective delivery of the teaching and learning process of Biology concepts in the country.

Keywords: Biology Concept, Performance, Science Learning Materials, Retention

A. Introduction

Science describes the natural presence of man and his actions. The significant goal of Science is for students to acquire scientific skills to improve the economy that leads to the comfortable standard of living of mankind (Dela Fuente, 2019). There are diverse definitions of science by various schools of thought; Ladele (2014) defines science as an integrated part of human activities. It is seen as a dynamic human activity concerned with manipulating a sphere-shaped world. It is seen as "knowledge covering general truths and laws, obtained and tested through scientific methods as concerned laws with the physical world." Science can be understood as the basis of national development. A nation that is not scientifically progressive is termed a regressive nation. Science is used by humans to solve daily problems and control the environment.

Biology is defined as the study of living things, which include plants and animals. It is a captivating study that ranges from microscopic-cellular molecules to the biosphere, covering the earth's surface and its living organisms (Sarigin, 2010). Biology is a core subject that is compulsory in all secondary schools in Nigeria. It is a pre-requisite to the study of many courses significant to humanity which include the following; Medicine, Physiology, Botany, Pharmacy, Biochemistry, Agriculture, Anatomy, Zoology. Other courses are Microbiology, Entomology, Immunology, Molecular biology, Cell Biology, Ecology, Evolutionary, Genetics, and population dynamic among others. Biology can be suitably taught in a laboratory, which is a place arranged and equipped with science materials for teaching and learning. It is clear that most secondary schools in Nigeria lack physical laboratories and where they exist, there are insufficient. One of the hitches affecting effort to enhance science is insufficient or absence of science teaching aids or materials, which include; indoor or outdoor laboratory, reagents, chemicals, and unqualified teachers.

One of the major problems facing most secondary schools in Nigerian society today is the relative deterioration in the academic performances of the students, especially in science subjects like biology. The secondary schools in Oyo State, Nigeria, are no exception. The science performances of students have been on the drop, and being able to reach the expected goal can be termed performance. The poor performances in biology could be traced to some factors such as lack of use of science apparatus, lack of funds to buy science material. The implementation and frequent effective use of science learning materials in teaching Biology to secondary school students is always a difficult task. This has made educational stakeholders like policymakers, teachers, and special educators to express worry over the uncomfortable and disappointing performance of students in Biology. This unsatisfactory performance could be attributed to faulty science learning materials in schools, which have contributed to the retention rate of students in understanding science concepts, incorrect use and wrong choice of science learning materials, occasional use of science learning materials, and so on.

According to a study carried out by Ajayi (2004), science learning materials have not been well applied and correctly utilized in most schools. This also poses many challenges to the retention and overall academic performance of secondary school students in Biology. It is in view of these assertions that the researchers tend to study the effects of science learning materials on performance and retention of biology concepts among secondary school students in Afijio local government area of Oyo State. The general purpose of this study, is to find out the effects of science learning materials on performance and retention of biology concepts among senior high school students. Specifically, the study aims that the biology concepts in teaching students of the senior secondary in community secondary school, is to determine the impact of the appropriate use of science learning materials on the academic performance of students in Biology concepts, and to determine the extent to which active and frequent use of science learning materials affect the retention rate of students in understanding concepts of biology.

B. Literature Review

1. *Meaning and Types of Science Learning Materials*

The significance of Biology is so vast that it needs to be taught with science learning materials to stimulate students' interest and assist the retention of concepts. Gbodi and Laleye (2014) lamented that abstract teaching goes on today, where science teachers do not use apparatus, and students are not using textbooks. It is informed that most secondary schools do not have a biology laboratory. The few remaining ones have been changed into classrooms to make space for the overwhelming population of students. The Science educational learning materials aid teachers to deliver effectively the quality teaching and learning through the integration of technology in the educational system (Dela Fuente, 2021; Dela Fuente & Biñas,

2020). According to Jegede and Okebukola (2012), professionally qualified science teachers, no matter how well trained, would not be able to put his thoughts into practice if the school situation is deficient in the equipment and science learning materials necessary to transform potentials into reality. The use of science learning materials is an essential tool in the teaching of Biology.

The aim of any educational process decides the content, methods, and materials required for realizing such aims. Different science learning materials are used for different concepts in Biology. Kehinde (2000) mentioned four types of science learning materials, which include the following: first, *Visual Aids* - these are science learning materials that make a visual impression; that is, it reads the vision of the eyes. They are chalkboard, posters, models, motion pictures, projected transparencies. Second, *Auditory Aids*- these appeal to the sense of hearing and are record players, tape recorders, and language laboratories. Third, *Audiovisual Aids*- these include both hearing and visual senses, e.g., based on sound and vision. Development in modern technology has led to the fabrication of devices known as Information Communication Technology (ICT), which is also used in teaching. The last is *Stimulation Devices* which include devices built to stimulate the actions and function of real things or objects. Instructional materials, according to Nbina and Obomanu (2011), have the characteristics of holding the attention of almost all the students because they reinforce verbal messages by providing a multi-media approach.

2. *Its Usefulness and Relevance to Learners*

The prominence of science learning materials, according to Nbina and Obomanu (2011), on assessment of the effects of problem solving instructional strategies on students' achievement and retention in chemistry with respect to location in River state, Nigeria, stressed that no matter how good a curriculum maybe, lack of the use of science learning materials can endanger its actual implementation. The choice and usage of science learning materials depend on the teachers, and if the science or biology teacher does not have the expertise to manipulate the materials, learning becomes difficult. Science teachers should devote passionate and creative enough to innovate science teaching materials to stimulate the interest of students towards biology concepts (Dela Fuente, 2021).

The provision and use of science learning materials should be strengthened in the school system because it is on this note that the effect of science learning materials on academic performance of Biology students, could be determined by their interactive and involvement in class which is based on the teacher's presentation of the biology concepts or subject matter. Both performances and long term performance could be measured by test analysis designed. A science learning material arouses student's contribution in class, increase the rate of retention, understanding and affects the performance of biology students. The use of inappropriate science learning material results such as wrongly labeled charts results in several academic problems, which, according to Josiah and Okaoboh (2011), ranges from mass failure or underperformance in public examination to the steady failing situation in an educational institution at all levels. Science learning materials are seen as an enhancement and great relief for science teachers in imparting knowledge and making the message clearer, more exciting, and more comfortable for the learners to assimilate (Akude & Ofoefuma, 2014).

Retention is the capability to store what has been learned and recall what has been stored in memory. According to Bichi (2002), retention is the capability to retain and later remember information or knowledge gained after learning into memory. The nature of the materials to be coded contributes to the level of retention. Science learning materials contribute to quality and level of retention in terms of meaningful, concreteness, and image evolving characteristics. According to Josiah and Okaoboh (2011), there is no need for teaching if what is learned cannot be recalled. The nature of the materials to be coded contributes to the level of retention. Science learning materials contribute to quality and level of retention in terms of meaningful, concreteness, and image evolving characteristics. According to Josiah and Okaoboh (2011), there is no need for teaching if what is learned cannot be recalled. It is essential to find out the prevailing situation in secondary schools in Afijio Local Government Area of Oyo State. Therefore, this study intends to look into the effects of science learning materials on the performance and retention of biology concepts among secondary school students.

C. Methodology

1. Research Design

The study utilised quasi-experiment involving pretest; posttest equivalent groups design were taught the same concepts without any science instructional materials for 3 weeks. The two groups were pretested and post-tested for performance and retention, respectively.

2. Participants

The population of a study refers to the totality of subjects, elements, or an individual, for whom a problem is concerned, on whom measurement has been made, and from whom generalizations are drawn. With regards to this study, the target population consists of all Senior High School students in Community Senior Secondary in the Afijio Local Government Area of Oyo State. The experimental groups (twenty students) were then taught Biology concepts using science instructional materials while the control groups (twenty students) were not taught any using Biology concepts using science instructional materials.

3. Sampling Technique

The sampling technique used in this study was simple random techniques. A lottery method of sampling techniques was used. According to William (2005), a lottery method of sampling, the researcher randomly picks numbers with each number to correspond to subject in order to create the sample. To create a sample this way, the researchers ensure that the items were mixed well before selecting the sample population. A total of forty (40) students were pretested to ascertain their group equivalence and then asked to pick from the mixed items that contain paper ramped with both A and B, where A stands for control group while B stands for the experimental group. Inside the box, after which they divided into two according to what they pulled out, the experimental groups were exposed to treatment, that is, were taught biology concepts with the use of science learning materials. In contrast, the control groups were taught the biology concepts without using science learning materials.

4. Instruments

The instrument designed and used for this study was a performance test designed by the researchers from the past West African Examination Council (WAEC) questions on the Biology concept known as a Biology Performance Test (BPT). The Biology Performance Test (BAT) was used as a pretest, to establish the group equivalence of the experimental and control groups and also used as a posttest to ascertain performance and as a posttest to ascertain their retention level. Twenty (20) items of Biology Performance Test were drawn from past West African Examination Council (WAEC) questions on the concept of the cell, the concept of Ecosystem, and skeletal system. The questions were selected to cover both theoretical and practical knowledge to determine the effects of science learning materials.

5. Validity and Reliability

The validity of an instrument simply means the ability of the instrument to measure what it intends to measure accurately (Arisi, 2002). The content validity of Biology Performance Test (BPT) was subjected to the scrutiny by experts in the field of Biology. To ensure the reliability of the instrument, before the study, BPT was subjected to a test – re-test analysis with a two-week interval on performance and retention ability of students in biology in non-participating school (N = 20), with a reliability index of 0.89 using Pearson Correlation coefficient to determine the measure of internal consistency. This index indicated that the items have relatively high internal consistency. Thus, the researcher-made instrument was found to be valid and reliable to be utilized in the conduct of the present study.

6. Procedure for Data Administration

The researchers administered the test instrument in selected schools with the assistance of two Biology teachers. The instrument was collected, marked, and recorded as a pretest. Biology teachers from the various schools were used as research assistants to invigilate and collect test items at the end of the test. The Experimental Group was taught Biology concepts on cell, Ecosystem, and skeletal system using science learning materials, like bones, models, and charts. In contrast, the Control Group was taught the same concepts without using any science learning materials. Both Groups were posttested to determine the performance of each treatment. Two weeks later, their retention ability was tested.

7. Data Analysis

The procedure for data analysis is determined by the type of data (biological concept, science learning materials used, pretest, and posttest performance and retention scores). The student's performance test used in this study involved interval data, which brings out their differences in the mean score (posttest performance score) of students using simple percentage mean and standard deviation.

D. Findings and Discussion

1. Findings

Research Question 1: What are the biology concepts in teaching students in senior secondary school, Jobele?

Table 1. Analysis of Biology Concepts

Concepts	Instructional Materials	Description
Concept of cell	Charts	Charts containing a diagram of plant and animal cell
Ecosystem	Charts	Charts containing the diagram of the food chain and food web; illustrating primary consumer, secondary consumer and decomposer
Skeletal System	Model	Chart showing human skeletal system Model of Human skeleton

Table 1 above shows the three different concepts (concepts of cell, Ecosystem, and skeletal system). The table revealed that the concept of cells that contain charts containing a diagram of plant and animal cells. The concept of Ecosystem that contains charts containing the diagram of the food chain and food web, illustrating primary consumer, secondary consumer, and decomposer. The concept of the skeletal system that contains the use of a model of a human skeletal system.

Research Question 2: What are the effects of science learning materials on the academic performance in the biology concept among community secondary schools in Afijio local government area of Oyo State?

In the concept of cell biology, the table above shows the score both control group (students taught without science learning materials) and experimental group (students taught with science learning materials) in the concept of a cell in Biology. The table revealed their score before (pre-score) and after (post-score) the experiment. The table revealed that out of 20 (100%) of the students taught without science learning materials (Control Group), 15 (75%, $x=9.27$; $SD=3.26$) failed in the pre-score test while 5 (25%; $X=18$; $SD=2$) passed. The table also revealed that 12 (60%, $x=8.25$; $SD=2.83$) of these students failed the post-score test while 8 (40%; $x=17.38$; $SD=1.87$) passed the post-score test. The table also revealed that out of 20 (100%) of the students taught with science learning materials (Experimental Group), 13 (65%; $x=7.54$; $SD=3.13$) failed in the pre-score test while 7 (35%; $x=17.86$; $SD=3.13$) passed. The table also revealed that 7 (35%; $x=17.85$; $SD=1.41$) of these students failed the post-score test while 13 (65%; $x=20$; $SD=2.72$) passed the post-score test. It is clear from Table 4.1 that the percentage score, (%) mean (\bar{x}) the standard deviation (S.D.) of the experimental group taught using science learning materials in the concept of a cell which is 65%; 20; 2.72 respectively is greater than that of the control group which is 40%; 17.38; 1.87 taught without science learning materials. This means the use of science learning materials enhances students' performance and retention ability of the students. Analysis of Effect of Science Learning Materials on Biology Concept can be seen on table 2

Table 2. Analysis of Effect of Science Learning Materials on Biology Concept

Concepts	Group	N	PRE-SCORE		POST-SCORE	
			FAILED	PASSED	FAILED	PASSED
Cell	Control Group	20	15	5	12	8
	%	100	75%	25%	60%	40%
	X		9.27	18	8.25	17.38
	S.D		3.26	2	2.83	1.87
	Experimental Group	20	13	7	7	13
	%		65%	35%	35%	65%
Ecosystem	Control Group	20	13	7	11	9
	%		65%	35%	55%	45%
	X		7.23	17.86	9.73	17.44
	S.D		2.94	1.46	2.83	1.71
	Experimental Group	20	8	12	3	17
	%		40%	60%	15%	85%
Skeletal system	Control Group	20	13	7	9	11
	%		65%	35%	45%	55%
	X		9.38	17.43	8.33	18.64
	S.D		3.27	1.18	1.94	2.50
	Experimental Group	20	10	10	4	16
	%		50%	50%	20%	80%
	X		10	17.5	7.75	20.63
	SD		1.26	1.63	2.28	3.71

The table also shows the score of both control group (students taught without science learning materials) and experimental group (students taught with science learning materials) in the concept of a cell in the Skeletal System. The table revealed their score before (pre-score) and after (post-score) the experiment. The table revealed that out of 20 (100%) of the students taught without science learning materials (Control Group), 13 (65%; $x=9.38$; $S.D=3.27$) failed in the pre-score test while 7 (35%; $x=17.43$; $S.D=1.18$) passed. The table also revealed that 9 (55%; $x=8.33$; $S.D=1.94$) of these students failed the post-score test while 11 (55%; $x=18.64$; $S.D=2.50$) passed the post-score test. The table also revealed that out of 20 (100%) of the students taught with science learning materials (Experimental Group), 10 (50%; $x=10$; $S.D=1.26$) failed in the pre-score test while 10 (50%; $x=17.5$; $S.D=1.26$) also passed. The table also revealed that 4 (20%; $x=7.75$; $S.D=2.28$) of these students failed the post-score test while 16 (80%; $x=20.63$; $S.D=3.71$) passed the post-score test. It is clear from the table that the percentage score (%), mean (x), and standard deviation ($S.D$) of the experimental group taught using science learning materials in the Skeletal System which is 80%; 20.63; and 3.71 respectively is greater than that of the control group which is (55%; 18.64 and 2.50) taught without science learning materials. This means the use of science learning materials enhances the performance and retention ability of the students in the teaching the concept of the skeletal system in biology.

Research Question 3: What is the effect of the use of instructional materials on the retention ability of biology concepts of students?

Table 3. Analysis of Effect of Instructional Materials on Retention Ability

Concept	Chart		Model	
	Pretest Failed	Post-test Passed	Pretest Failed	Post-test Passed
Cell	7	13	-	-
Percentage	35%	65%	-	-
Ecosystem	3	17	-	-
Percentage	15%	85	-	-
Mean	9.67	19.94	-	-
S.D	3.30	2.80	-	-
Skeletal	-	-	4	16
Percentage	-	-	20%	80%

The table above shows the number of students that failed the post-test and the number of students that passed the post-test. It revealed that at pretest out of 20 students taught with Chart in the concept of Cell and Ecosystem in Biology, 7 (35%) failed while at post-test 13 (65%) passed. Also, the table revealed that at pretest, out of 20 students taught with a model in the concept of Skeletal system in biology, 4 (20%) failed while at posttest 16 (80%) passed. This implies that more students passed at the posttest, meaning that capable, more students passed the use of science learning materials in teaching concepts of Cell, Ecosystem, and Skeletal system have a positive influence on the retention ability of students.

2. Discussion

This study investigated the effects of the use of science learning materials on performance and retention of biology concepts among secondary school students. The Biology Performance Test (BPT) was used as a pretest, to establish the group equivalence of the experimental and control groups and also used as a posttest to ascertain performance and as a posttest to ascertain their retention level on the concept of Cell, Concept of Ecosystem and Skeletal System. About research question 1, which aimed to ascertain the science learning materials suitable in teaching the concept of cell, Ecosystem, and skeletal system to secondary school students in community secondary school Jobele. The study revealed that the chart was used in the teaching the concept of cell and Ecosystem while the model was used in teaching the concept of the skeletal system. The study agreed with the opinion of Johnson (2010) that stated that the proper use, careful selection, and skillful handling of science learning materials by the teacher that renders its usefulness in facilitating learning.

About research question 2, which aimed to ascertain the effect of science learning materials on the academic performance in biology concept among community secondary school. The result of the findings revealed the analysis of post-test scores of experimental and control groups using simple percentage revealed that students who were exposed to the use of the science learning materials in the teaching of biology concepts significantly performed better than those not exposed to the use of science learning materials. This means that the use of science learning materials in the teaching of biology concepts increased students' academic performance in the subject. These findings conform with that of Johnson (2010) Eshiet (2009) and Balogun (2015), where it was found that teachers' use of science learning materials in teaching improved students' performances.

About research question 3 which aimed to ascertain the effect of the use of science learning materials on retention ability of biology concepts of students, the result of the findings revealed that at pretest, out of 20 students taught with a model in the concept of Skeletal system in biology, 4 (20%) failed. In contrast, at posttest 16 (80%) passed. This implies that more students passed at the posttest, meaning that the use of science learning materials in the teaching concept of Cell, Ecosystem, and Skeletal system has a positive influence on the retention ability of students. This implies that the effective use of science learning materials (chart and model) in teaching the concept of cell, Ecosystem, and skeletal system have enhanced the retention ability of students in community secondary school, Jobele. This is also in line with Gbodi and Laleye (2014), who posited that the importance of Biology is so much that it needs to be taught with science learning materials to arouse students' interest and facilitate retention of concepts. Ehuosu (2008) mentioned seven essential roles of using science learning materials, which include extension of human experience, provision of meaningful information, stimulation of interest, the grouping of students' interest, overcoming physical limitation, and

stimulating problem solving and providing diagnostic and remedial tools for teachers in teaching.

E. Conclusion

The study focused on the use of science learning materials on performance and retention of biology concepts among secondary school students in Afijio Local Government, Oyo. The study was able to reveal that the use of instructional materials in the teaching of Biology concepts significantly improves the academic performances of students involved in the study. The use of instructional materials enhances the retention ability of students. Also, students exposed to the use of instructional materials in the teaching of biology concept generally had better academic performances and retention ability than students who were not exposed to the use of instructional materials in the experiment.

This study will be of great significance to Biology teachers in Oyo State in particular and in Nigeria in general. Teachers would find this study relevant and useful in teaching and learning procedures. The outcome benefit of this research work will also help curriculum planners in making the necessary adjustments in the area of practical works and recommendation of appropriate science learning materials in teaching and learning of Biology and other science disciplines.

Science equipment manufacturers and science book publishers and so on will find this study relevant in areas of science learning materials production to schools. Lastly, this present research study may also be useful to other researchers who may want to venture into the same study in other science disciplines such as physics, chemistry, and so on.

Based on the findings emanating from this study, the following recommendations are suggested:

1. The Ministry of Education may consider to provide science learning materials for effective teaching and learning of Biology concepts in Oyo State Senior Secondary Schools.
2. Stakeholders like the PTA do not abbreviate for it provides different meaning to international readers, should also make an effort to provide science learning materials to schools.
3. The pre-service teachers' curriculum in the colleges of education should emphasize the use of science learning materials in Biology teaching.
4. Teachers should be fully and adequately trained to make use of science learning materials through regular workshops and seminars.

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