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EFFECTS OF BIOLOGICAL SCIENCE INQUIRY MODEL AND CONCEPT ATTAINMENT MODEL ON STUDENTS' RETENTION IN ADAMAWA STATE, NIGERIA

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ABSTRACT

This study was conducted to determine the effects of biological science inquiry model and concept attainment model on students' retention in Adamawa state, Nigeria. 3 objectives were stated; 2 research questions were raised and answered. 3 hypotheses were formulated and tested at 0.05 level of significance. A quasi-experimental research design involving non-randomized, pretest-posttest, experimental, control groups was employed. The population of this study included all year 2 (SS II) Senior Secondary Schools students in Adamawa state. A multistage sampling method was employed. 330 students from six intact classes of six secondary schools of Gombi education zone of Adamawa state were sampled out for the study. The instruments that was used for data collection was Biology Retention Test (BRT). The research questions were answered using descriptive statistics of mean and standard deviation while hypotheses were tested at 0.05 level of significance using two-way Analysis of Covariance (ANCOVA). Results of this study showed significant difference in the mean retention scores of students when taught biology using BSIM, CAM and lecture method, F = 10.76 (df 2, 329), P = 0.00; no significant difference in the mean retention scores of male and female students when taught biology using BSIM, CAM and lecture method, F =1.553 (df 1, 329), P = 0.214; no significant interaction effect of biological science inquiry model, concept attainment model, lecture method and gender on biology students' retention in Adamawa State, F =0.523 (df 2, 329), P = 0.592;

Keywords: biology, retention, inquiry, attainment, concept

INTRODUCTION

Science education prepares students for shifting from the teacher-centered methods of teaching science to child-centered activity-based methods which encourage and develop spirit of inquiry, curiosity, investigation, critical thinking and reasoning ability; it provides understanding of scientific thinking, scientific innovation and scientific approach (Akinbobola & Afolabi, 2010). Science is an integral part of human activity. The acquisition and utilization of scientific knowledge are shouldered upon science educators to produce scientifically educated citizens that are capable of solving problems in order to be self-reliant. Biology is one of the science subjects. It is a science subject concerned with the study of life and living organisms including their structure, function, and growth (Bozie, 2014). Arokoyu and Aderonmu (2018) asserted that science education is considered as a double scholarly discipline because of its application of scientific theories, facts, principles and laws utilizing educational theories and practice in conveying the fluid body of knowledge to learners.

Retention is the ability of an individual to store and recall or remember stored information. Information gained during teaching and learning process is to be retrieved. Academic retention therefore refers to the ability of students to retrieve gained information during teaching and learning process. Retention is seen as a positive aspect of memory while forgetting is seen as the negative aspect (Enebechi, 2021). The acquired materials in the mind need to be preserved in form of images for knowledge to develop. When a stimulating situation occurs, retained images are revived or reproduced to make memorization possible. Biology concepts therefore, need to be presented to the learners in a way or method that touches their sub consciousness (Enebechi, 2021).

Retrieval of information from long-term memory depends to some extent on whether the information was well organized when first stored. For the information to be well retained and retrieved, appropriate method of teaching is needed. Appropriate instructional design for adequate instructional delivery is required for the retention of information gained during teaching and learning process. Active involvement, frequent reviews, tests and elaborated feedback of students in learning projects have been associated with longer retention, while active participation during instruction increases learning and retention (Enebechi, 2021).

Retention of information learned by students can be improved through attention, active learning, and meaningfulness. Information that is not attended to does not enter into the information processing system (Gagne, 1985). Glover, Bruning, and Filbeck (1983) stated that without students' attention to the task at hand, learning cannot occur; thus, attention is a necessary precursor for learning. In order to focus student attention on the learning tasks, both effective motivational and classroom management skills are necessary for learning to take place. Research has demonstrated clearly that students learn best when they are actively involved in the learning process. (Kiausmeier, 1985). When material is made meaningful, it is learned more rapidly and retained for longer periods of time than rote learning (Brown, 1975). Edelman and Edelman (2017) reported that inquiry-based instruction expands science knowledge retention far longer than traditional lecture method-based instruction. Information that is not attended to does not enter

into the information processing system (Gagne, 1985). Without a student's attention to the task at hand, learning cannot occur. Thus, attention is a necessary precursor for learning to occur. Therefore, learning activities should be organized in such a way as to capture the attention of students so that information learned should be stored for further retrieval. Joda and Mohammed (2017) conducted a study titled 'effect of guided inquiry teaching method on senior secondary school biology students' academic Performance and retention in Yola education zone, Adamawa state, Nigeria'. The design that was employed for the study was quasi experimental research designed involving pre-test, posttest control groups. The population of the study was all the senior secondary school year two students (SSII) in Yola education zone. Stratified random sampling technique was used to select 119 biology students. The experimental group was taught through guided inquiry and the control group was taught through lecture method. Mean and standard deviation was used to answer one research question and analysis of covariance (ANCOVA) was used to test two hypotheses.

Findings of the study showed that students taught with guided inquiry method have a significantly higher academic Performance than those taught with lecture method while those taught with lecture method retained biology concepts more than those taught with guide inquiry method. Joda and Mohammed recommended that curriculum planners should incorporate guided inquiry method in the teaching of biology in order to promote students' academic Performance and lecture method should be used by biology teachers when necessary to enhance retention of concepts. Waziri (2018) investigated the effect of biological science inquiry model of teaching on secondary school students‟ cognitive achievement and retention in biology in Senior Secondary School Students in Adamawa state, Nigeria. The design adopted for the study was Koksal‟s randomized five-group experimental design for science education studies (KRFEDSED). Data raised were analyzed using two-way multivariate Analysis of Covariance (MANCOVA). Result of the study showed that, biological science inquiry model enhanced students‟ cognitive performance as well as retention in biology at both posttest and retention test. On gender difference, the scholar reported from the study that there was significant difference between male and female students in the experimental group. The result showed that male students outperformed their female counterparts on posttest level only. Waziri recommended that biological science inquiry model should be incorporated in the teaching of biology for meaningful learning and that workshops should be organized for pre-service and practicing teachers on how to use biological science inquiry model. Enebechi (2021) investigated the effect of inquiry-based learning approach on senior secondary school biology students' retention in Enugu East Local Government Area of Enugu, Nigeria. It was a quasi-experimental, pre-test, post-test, non-equivalent control groups design. The population of the study comprises 2624 senior secondary (SS2) biology students. A sample size of 139 SS II biology students was used for the study. Influence of gender on mean retention scores of students when taught biology with inquiry-based learning (IBL) approach was also investigated in the study. The interaction effect of gender and strategy was also investigated. Two research questions were posed and three null hypotheses were formulated to guide the study. Two instruments were used for data collection in this study namely: Biology Performance Test (BPT) and Biology Retention Test (BRT). The instrument was validated by three experts in the

Department of science Education (Measurement and evaluation and biology units) all in faculty of Education, Enugu State University of Science and Technology).

The reliability index of the instrument was 0.89 using Kuder- Richardson Formular 21(K-R 21). The research questions were answered using mean and standard deviation, while Analysis of covariance (ANCOVA) was used to test the hypothesis at 0.05 level of significant. The results of the study revealed that IBL approach is more effective than lecture method approach in enhancing students' retention in Biology. Secondly, IBL approach enhances gender parity as it concerned students' retention in Biology. Based on these findings, the educational implications were identified and highlighted. It was recommended among others that biology teachers should adopt the use of inquiry-based learning approach in their lessons in order to enhance students' retention ability in biology. Both studies show similarity in having inquiry in biology Performance and retention but they differ in number of variables. For this study, there is an addition of CAM as a variable that can interact with BSIM.

Downing (2022) conducted a study on effects of scientific inquiry methodologies on student understanding of evolution in biology. Area of the study was Midwestern United State. The purpose of the study was to investigate the effect of a scientific inquiry-based method of teaching on student understanding of evolution. The design of the study was aquasi experimental design. The population for the study was tenth and eleventh-grade students enrolled in a general biology course at a large sub-urban high school in Mid-Western United States (ages 15-17). 28 students (featured 14 females and 14 males.) formed the sample of the study.

Statement of the Problem

It is observed that the retention ability of students in senior secondary school is low. The researcher therefore embarked on a study "effects of information processing teaching models on senior secondary school students' academic performance and retention in Adamawa state, Nigeria to see if teaching method as one of the factors affecting performance and retention is a contributory factor.

Research Questions

1. What are the mean retention scores of students when taught biology using biological science inquiry model, concept attainment model and lecture method?
2. What are the mean retention scores of male and female students when taught biology using biological science inquiry model, concept attainment model and lecture method?

Hypotheses

H_{O1}. There is no significant difference in the mean retention scores of students when taught biology using biological science inquiry model and concept attainment model and lecture method.

H_{O2}. There is no significant difference in the mean retention scores of male and female students when taught biology using biological science inquiry model, concept attainment model and lecture method.

H_{O3}. There is no interaction effect of biological science inquiry model, concept attainment model and

gender on students' retention.

METHODOLOGY

This study was carried out in Adamawa state on SS 2 students. It was a\ quasi-experimental research design involving non-randomized, pretest-posttest, experimental, control groups. This design was employed because it was not possible to randomize the subjects (students) and so intact classes were used to avoid disruption of normal class lessons (Njoroge, Changeiywo, & Ndirangu, 2014).

RESULTS

Research Question 1. What are the mean retention scores of students when taught biology using biological science inquiry teaching model, concept attainment teaching model and lecture method?

Table 1: Mean and Standard Deviation of Retention Scores of Students Taught with Biological Science Inquiry Model, Concept Attainment Model and Lecture Method

		Pretest		Retention	
Model	N	Mean	SD	Mean	SD
BSIM	114	16.41	6.13	21.56	9.57
CAM	111	13.84	6.12	17.14	6.97
Lecture	105	17.76	5.53	17.15	7.61

The descriptive statistics in Table 1 showed that Biological Science Inquiry Model with 114 students has a pretest mean score of 16.41 and standard deviation of 6.13**.** On retention, biological science inquiry model has a mean score of 21.56 and standard deviation of. 9.57. Concept attainment model with 111 students has a pretest mean score of 13**.**84 and standard deviation of 6**.**12. On retention, concept attainment model has mean score of 17.14 and standard deviation of 6.97. Lecture Method with 105 has a pretest mean score of 17**.**76 and standard deviation of 5**.**53. On retention, lecture method has mean score of 17.15 and standard deviation of 7.61. In summary, the mean difference between pretest and retention is high which means students have retention capability.

Research Question 2 What are the mean retention scores of male and female students when taught biology using biological science inquiry model, concept attainment model and lecture method?

Table 2: Mean and Standard Deviation of Retention Scores of Students Taught with Biological Science Inquiry Model, Concept Attainment Model and Lecture Method Based on Gender

		Pretest		Retention	
	n	Mean	SD	Mean	SD
BSIM					
Male	53	18.19	5.77	22.08	10.34
Female	61	14.87	6.06	21.11	8.92
CAM					
Male	62	15.08	7.07	17.45	6.94
Female	49	12.27	4.21	16.76	7.05
Lecture					
Male	47	18.10	5.75	18.66	8.41
Female	58	17.48	5.37	15.93	6.71

The descriptive statistics in Table 2 showed that Biological Science Inquiry Model (BSIM) has 53 male students and 61 female students. The mean score of male students is 18.19 and standard deviation of 5.77. The mean score of females is 14.87 and standard deviation of 6.06. On Retention, the mean score of male students is 22.08 with standard deviation of 10.34. The mean score of females on Retention is 21.11 with standard deviation 8.92. Concept Attainment Model (CAM) has 62 male students and 49 female students. The mean score of male students is 15.08 and standard deviation of 7.07. The female students have mean score of 12.27 and standard deviation of 4.21. On Retention the mean score of male students is 17.45 with standard deviation of 6.94. The mean score of females on retention is 16.76 with standard deviation 7.05. Lecture method has 47 male students and 58 female students. The mean score of male students is 18.10 and standard deviation of 5.75. The mean score of female students is 17.48 and standard deviation of 5.37. On retention, the mean score of male students is 18.66 with standard deviation of 8.41. The mean score of female students on retention is 15.93 with standard deviation 6.71. In summary, with biological Science Inquiry Model the mean score of males is higher than that of male on retention. With Concept Attainment Model, the mean score of male students is higher than that of female. With lecture method too, the mean score of male students is higher than that of female.

Testing Hypotheses

H_{O1}. There is no significant difference in the mean retention scores of students when taught biology using biological science inquiry model and concept attainment model and lecture method.

Table 3: ANCOVA of Biological Science Inquiry Model, Concept Attainment Model and Lecture Method on SS II Biology Students' Academic Retention in Adamawa State.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1481.372[a]	3	493.791	7.423	.000	064
Intercept	12607.422	1	12607.422	189.513	.000	368.
PRETEST	28.043	1	28.043	422	517	.001
MODELS	1431.033	2	715.516	10.756.	.000	062
Error	21687.282	326	66.525			
Total	138230.000	330				
Corrected Total	23168.655	329				

a. R Squared = .064 (Adjusted R Squared = -.003) = Significant P = < 0.05

The results of the analysis in Table 3 shows that, there is significant difference in the mean retention scores when taught biology using biological science inquiry model, concept attainment model and lecture method in Adamawa State. F = 10.76 (df 2, 329), P = 0.00. Since the computed p-value (0.00) is less than 0.05 level of significant, therefore, the null hypothesis of no significant effect is rejected, and concluded that there is significant difference in the mean retention scores when taught biology using biological science inquiry teaching model, concept attainment teaching model and lecture method in Adamawa State.

H_{O2}. There is no significant difference in the mean retention scores of male and female students when taught biology using biological science inquiry model, concept attainment model and lecture method.

Table 4: Summary of ANCOVA of SS II Male and Female Biology Students' Academic Retention in Adamawa State

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	159.606[a]	2	79.803	1.134	323	007
Intercept	13261.136	1	13261.136	188.465	000.	.366.
PRETEST	28.414	1	28.414	404	526	.001
GENDER	109.266	1	109.266	1.553.	.214.	.005
Error	23009.049	327	70.364			
Total	138230.000	330				
Corrected Total	23168.655	329				

a. R Squared = .007 (Adjusted R Squared = -.001)

The results of the analysis in Table 4 shows that, there is no significant difference in the mean retention scores of male and female students' when taught biology using biological science inquiry model, concept attainment model, and lecture method. F =1.553 (df 1, 329), P = 0.214. Since the computed p-value (0. 214) is greater than 0.05 level of significant, therefore, the null hypothesis of no significant difference is upheld and concluded that there is no significant difference in the mean retention scores of male and female students' when taught biology using biological science inquiry teaching model, concept attainment teaching model, and lecture method in Adamawa State.

H_{O3}. There is no interaction effect of biological science inquiry model, concept attainment model and gender on students' retention.

Table 5: Summary of ANCOVA of Interaction Effects of BSIM, CAM, Lecture Method and Gender on SS II Biology Students' Retention in Adamawa State.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1699.236[a]	6	283.206	4.261	.000	.073
Intercept	12462.329	1	12462.329	187.491	.000	.367
PRETEST	13.170	1	13.170	.198	.657	.001
MODELS	1406.888	2	703.444	10.583	.000	.061
GENDER	150.601	1	150.601	2.266	.133	.007
MODELS * GENDER	69.804	2	34.902	.525	.592	.003
Error	21469.418	323	66.469			
Total	138230.000	330				
Corrected Total	23168.655	329				

a. R Squared = .073 (Adjusted R Squared = .056) = Significant P < 0.05

The results of the analysis in table 5 shows that, there is no significant interaction effect of biological science inquiry model, concept attainment model, lecture method and gender on biology students' retention ability in Adamawa State. F =0.523 (df 2, 329), P = 0.592. Since the computed p-value (0.592) is higher than 0.05 level of significant, therefore, the null hypothesis of no interaction effect is upheld.

DISCUSSION OF FINDINGS

The study was concerned with retention of biology concepts by students when exposed to biological science inquiry model and concept attainment model. Research questions focused on the mean and standard deviation of retention scores of students taught with biological science inquiry model concept attainment model and lecture method. Testing H_{O1}, findings of the study showed significant difference in the mean

retention scores of students when taught biology using biological science inquiry model, concept attainment model and lecture method in Adamawa State. This is a significant finding that supports the effectiveness of BSIM and CAM over lecture method in improving performance on assessments. The finding collaborates with that of Waziri (2018), Enebechi (2021), Joda and Mohammed (2017), Asy'ari, Wikanta and Juniawan (2022), Arokoyu and Aderonmu (2018).

Testing H_{O2}, findings of the study showed no significant difference in the mean retention scores of male and female students' when taught biology using biological science inquiry model, concept attainment model, and lecture method. this finding highlights the equality in learning potential between male and female students. This finding is a crucial consideration in developing educational interventions. The finding reveals the method of teaching that is unbiased and therefore good method of teaching. This finding disagrees with the finding of Enebechi (2021) who reported that inquiry-based learning approach enhances gender parity as it concerned students' retention in biology. On post-hoc analysis, findings showed out that Biological Science Inquiry Model and Lecture method are best for retention while Concept Attainment Model is the least.

Testing H_{O3}. findings of the study showed no significant interaction effect of biological science inquiry model, concept attainment model, lecture method and gender on biology students' retention ability in Adamawa State.

RECOMMENDATIONS

In light of the above, the study recommends that;

1. workshops for training biology teachers on how to use the models in teaching biology in senior secondary schools of Adamawa state should be organized for adequate retention of information by students.
2. With no significant gender difference in the mean retention scores of students, teachers should employ the use of the models in teaching biology since it has no gender bias

CONCLUSION

Based on the findings of the study, it is concluded that, BSIM, CAM and lecture method have significant effect on students' retention; On post hoc test BSIM was the best followed by lecture method while CAM was the least on students' retention. With regard to gender, there was no significant gender effect on retention.

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