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Impact of Teaching the Human Skeletal System using Models on Biology Student's Academic Performance and Retention in Uyo, Nigeria

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Abstract

The study examined the impact of teaching the human skeletal system using models on biology student's academic performance and retention in Uyo, Nigeria. The two models used were concrete and iconic. The concrete model used was the human skeletal system while a chart showing the human skeleton was used as the iconic model. The post-test performances as well as retention test performances of biology students taught using the concrete model were compared with those of their counterparts taught using the iconic model. The study also investigated the influence of gender on students' mean performance scores in biology with respect to concrete and iconic models. The design of the study was quasi-experimental, involving non-randomized pretest-posttest experimental group design. One hundred and forty-four (144) Senior Secondary one (SSI) Biology Students were drawn from two intact classes. The two intact classes were randomly assigned to concrete and iconic model groups, respectively. The biology performance Test (BAT) and Biology Retention Test (BRT) were administered as a Pre-test and Post-test and retention test, appropriately. Four research questions and four hypotheses were formulated to guide the study. The research questions were answered using descriptive statistics such as mean and standard deviation while the hypotheses were tested using Analysis of Covariance (ANCOVA). The results of the analyses showed that students taught using concrete models performed better than those taught with iconic models. Also, students taught using concrete model had a higher mean retention scores than those taught using iconic model. Gender was found to be a significant factor in students' performance as the male students performed better than the female students in both concrete and iconic models' groups. The same was observed with respect to retention. Judging from the findings of the study, I recommended that biology teachers employ the use of concrete models in teaching to enhance students' performance and retention.

Keywords: Models, Concrete model, Iconic model, Human skeletal system, Performance, Retention

INTRODUCTION

Science is a product of the mind seeking to review natural laws that govern the universe. It focuses on finding practical usage for scientific discoveries and knowledge (Na'allah, 2016). Science as an institution aims at building knowledge and offering accurate explanations of how the natural world works (Anaso, 2007; Kalu, 2007 and Ogunleye 2012). In recent times, science has attracted significant attention because of its role in driving the technological advancement of nations.

In Nigeria, science is taught at the secondary schools as basic science at the junior secondary school and as separate science subjects of Chemistry, Physics, and Biology at the senior secondary school levels (Onwuakpa and Nweke, 2009). Biology, as a branch of natural science, deals with the study of living organisms, including their structures, functioning, distribution, interrelationships, and evolution (Institute of Biology, 2013). The Nigerian secondary school biology curriculum is designed to facilitate students' investigation into natural phenomena and deepen their understanding and interest in biological sciences while encouraging them to apply scientific knowledge to everyday life (Federal Ministry of Education, 2013). At the secondary school level, biology is made a core science subject by the federal government of Nigeria and has the following objectives: providing adequate laboratory and field skills, providing relevant knowledge, building the capacity to apply scientific knowledge to everyday life, and developing functional scientific attitudes in students (Federal Ministry of Education, 2013).

Research indicates that some concepts in biology, which includes the skeletal system, contain some topics that are difficulty for biology students to understand (Esiobu and Soyibo, 2008). Many students have the notion that the skeletal system concepts are boring and can only be memorized (Zarotiadous and Tsaparlis, 2002 and Chew, 2014).

Nationally, the academic performance of students in biology is low and below expectation and the persistent failure of students in the subject has remained worrisome (Jegede, 2010). Giving the analysis on the tracks of mass failure in the National Examination Council (NECO) results, Adesulun of Vanguard expressed "It is sad to note that for five consecutive years, candidates writing the National Examination Council (NECO) examination have recorded mass failures. Apparently, the scenario is worrisome to education stakeholders as nobody knows at whose doorsteps to place the blame, students or NECO" (Adesulum, 2012). The analysis reported that in 2002 at NECO's maiden edition, most candidates passed their registered subjects including Biology and English Language which led to the public accusing the body of awarding cheap results to students. However, after 2007 NECO November/December where 65% had credit pass in Biology, the analysis said, the performances of candidates deteriorated every year, down to 11.3% in the 2011/2012 result, a situation which the reporter said called for concern

among stakeholders. During the NECO June/July 2011 examination, the analysis reported that less than 25% of the 1,160,561 candidates had passed at credit level in subjects including Biology. This implies that more than 870,421 candidates failed Biology and other subjects (Adesulum, 2012). In a similar vein, as reported by the WAEC Head of National Office, Yaba, Mr. Charles Eguridu, the result of May/June 2014 as was announced on Monday, 11 August 2014, witnessed a mass failure in Biology and English Language (Eguridu, 2012). He reported that 529,425 candidates representing 31.28% obtained credits in Biology and other four subjects. He noted that comparing this result to the 2012/2013 May/June result, there was a marginal decline in the performances of candidates. The report stated that in 2009, 25.99% obtained credits in Biology and English compared to 23.5% in 2008 among Nigerian candidates (Eguridu, 2012).

The reason for the poor performance includes the adoption of poor instructional delivery approaches, lack or improper use of instructional materials such as the use of models, unavailability of laboratory facilities, inadequate allocation of time and large class size (Etukudo, 2009; Salau (2012).

Models are generally considered concrete objects or representations utilized by teachers to make learning real (Eshiet, 2007). Models help to simplify complex systems making them easy to understand and comprehend (Ezeh, 2010). They are simplified devices that serve the purpose of depicting the actual object or desired feature. A model could designate a theory, a law, a classification, a hypothesis, or even science itself (Abler, Adam, and Gould, 2007). According to (Akpan, 2006), models are important in enhancing the effectiveness of teachers in the teaching-learning process, facilitating students' understanding, sustain the attention span of students while reducing mental strain and fatigue that may arise from abstraction.

Different authors adopt different modalities to classify models. For instance, Sowell (1974), classified models into concrete, pictorial, and abstract. However, for the purpose of this work, we will adopt the classification proposed by Bruner (2001), Akinsete (2007), and Eshiet (2007) which recognizes three types of models including concrete, iconic, and symbolic models. Concrete models are real objects or man-made casts that provide the representation of the features of the actual concept in three-dimensional planes (Eshiet, 2007). Unlike iconic and symbolic models, concrete models can be moved around or manipulated. Iconic models, on the other hand, could be pictures, diagrams, or sketches in 2-dimensional planes that represent the actual concept, making possible the recognition of the concept by looking at the sketches, diagrams, or pictures (Eshiet, 2003). The models involve the use of words or groups of words, letters, or signs to denote a phenomenon (Eshiet, 2007).

Models are widely adopted as part of instructional strategy and they are widely applied in science teaching. According to Abimbola and Mustapha (2002), the use of models in teaching improves the academic performance of the students and encourages active participation of the learners. For teachers, the use of models enhances the understanding of scientific concepts, promotes the construction of knowledge, and encourages active discovery and independent learning (Ibe-Basse, 2012).

Many researchers have studied the Effects of using models in teaching on the performance of science students. For instance, Owolabi (2007) reported that models have the ability to improve the performance and retention of students. The use of models also arouses students' interest and imagination and results in better understanding and retention of concepts according to Lagoke (2009). The study by Olarewaju (2012) reported a significant difference in the achievement of biology students when models were used in explaining the concepts. Sani (2006) in his study established that students taught with models performed significantly better than those taught with the lecture method.

Eshiet (2007) maintained that an important value of models in science and science education is the contribution to visualization of complex ideas, processes and systems. Okoro (2011) stated that models especially concrete and iconic has the tendency of enhancing students' performance and retention since it offers realistic experience which stimulate self-activity on the part of the learner.

Retention is the act of retaining or an ability to recall or recognize what has been learnt or experienced over a long period of time. Probably if what has been learnt is retained over a long period of time, it may lead to higher performance because retention is measured in collaboration with performances (Iji, 2010). Retention of concepts would help in reflective thinking and the retained concepts can be used in reflective ways to solve novel problems. In light of this Ochonogor (2007) said that "indepth retention and performance in science technology and mathematics is an important need that is becoming highly felt by the Nigerian populace P₁₉."

Akubailo (2004) reported that any model, which elicits adequate student's participation, has a profound effect on student's retention. Njoku (2014) opined that models concretize and elucidate difficult and abstract concepts thereby reducing students' problem of comprehension and application of concepts in problem solving. In this way models improve retention of knowledge and transfer of learning.

Research studies have shown that models enhance performance and retention of concepts in science while researchers such as Owolabi (2007) have shown that models improve performance and retention. Lagoke (2009) reported that the use of models arouse students interest and imagination and lead to understanding and retention of concepts. In this study, teaching with models would be used to see whether the result is the same or differently. Another variable which can affect student's academic performance is gender.

Gender issues and academic performance have become a very important issue among researchers. According to Nworgu (2014), there is an acknowledged problem of female underperformance when compared with their male counterparts apparently under equivalent conditions and this problem of female underperformance appears to be more pronounced in science and mathematics.

The term gender refers to socially ascribed roles, responsibilities, and opportunities associated with women and men, as the hidden power structures that govern relationships

between them. Gender is in essence, a term used to emphasize that sex inequality is not caused by the anatomic and physiological differences that characterize men and women, but rather by the unequal and inequitable treatment socially accorded to them (Igwe,2013). In this sense, gender alludes to the cultural, social, economic, and political conditions that are the basis of certain standards, values, and behavioral patterns related to genders and their relationship.

Gender is the different sociocultural stereotyped roles and responsibilities expected of men and women. Gender is a parallel and socially unequal division into masculinity and femininity (Eze, 2008). The gender issue is an important factor in educational settings and could be a hindrance to the high performance of learners in science (Igwe, 2013). Some research works have shown contradicting evidence in students' academic performance in science due to gender. For instance, Ifeakor (2011) found that there is no significant difference in the performance of male and female students in biology and chemistry respectively.

This study therefore examined the effects of teaching the human skeletal system using models on the Performance of Students in Biology in Uyo, Nigeria. The study compared the performance of students taught using concrete models with those taught using iconic models

Statement of the Problem

Over the years, the performance of students in biology examinations has remained poor. One of the main reasons for this is poor teaching strategies adopted by teachers during classroom instruction. Teaching strategy is very vital in any teaching/ learning process as the strategy adopted by teachers may promote or hinder learning. It may sharpen mental activities which are the basis for social power or may discourage initiative and curiosity, thus making self-reliance and survival difficult for students. Teaching strategies affect the response of students and could determine whether he is interested, motivated, or involved in any lesson. Student's poor performance has been attributed to teacher's failure to use effective teaching strategies such as the use of models as the cause of student's poor performance in biology. One of the effective ways to deal with this problem is for the teacher to provide a bridge between the unfamiliar concepts and the knowledge that the student possesses. This bridge can be the use of models which allows new materials, especially abstract concepts, to be easily assimilated with the student's prior knowledge thus enabling them to develop an understanding of the concepts. It is on this basis that the researcher is investigating the effects of teaching the human skeletal system using models on the performance and retention of students in biology in Uyo, Nigeria.

Purpose of the Study

The main purpose of the study is to examine "the effects of teaching human skeletal system using models on the performance of students in biology in Uyo Local Government Area in Akwa Ibom State, Nigeria". Specifically, the objectives of the study are as follows:

- (i) Compare the performances of students on the concept of human skeletal system in biology when taught using concrete and iconic models.

- (ii) Determine the differences in students' retention scores on the concept of human skeletal system in biology when taught using concrete and iconic models.
- (iii) Determine the performances of male and female students on the concept of human skeletal system when taught using concrete and iconic models.
- (iv) Compare the retention scores of male and female students on the concept of human skeletal system when taught using concrete and iconic models.

Research Questions

The following research questions were raised to guide the study:

- (i) What is the difference in the academic performances of students taught the concept of human skeletal system using concrete and iconic models?
- (ii) What is the difference in the retention scores of male and female students taught the concept of human skeletal system using concrete and iconic models?
- (iii) What difference exists between the academic performances of male and female students taught the concepts of human skeletal system using concrete and iconic models?
- (iv) No significant difference exists between the retention scores of male and female students taught the concept of human skeletal system using concrete and iconic models.

Research Hypotheses

The following null hypotheses were tested at 0.5 level of significance:

- (i) There is no significant difference in the mean performance scores of biology students taught the concept of human skeletal system using concrete and iconic models.
- (ii) No significant difference exists in the mean retention scores of students taught the concept of human skeletal system using concrete and iconic models.
- (iii) There is no significant difference in the mean performance scores of male and female students taught the concept of human skeletal system using concrete and iconic models.
- (iv) No significant difference exists between the retention scores of male and female students taught the concept of human skeletal system using concrete and iconic models.

RESEARCH METHODOLOGY

Design of the Study

The study adopted the quasi-experimental research design, precisely non-randomized pretest, posttest experimental group design. This was suitable because the researchers did not randomize respondents rather, they used intact classes.

Area of the Study

The study was conducted in Uyo Local Government Area of Akwa Ibom State. Uyo is a city and a local government area in the South-South Nigeria and is the capital of Akwa Ibom

State, a major oil producing state. The town became the capital of Akwa Ibom State on September 23, 1987 following the creation of Akwa Ibom State from the erstwhile Cross River State. It has thirteen (13) public secondary schools two higher institutions are also established; they are the University of Uyo and Uyo City Polytechnic.

Population of the Study

The population of the study comprised of all the senior secondary one (SS1) Biology students in all the 13 public secondary schools in Uyo Local Government Area of Akwa Ibom State for 2022/2023 academic session. The estimated population size was 1,100 SS1 Biology Students.

Sample and Sampling Technique

The study sample consisted of 144 SS1 Biology students drawn from two selected schools in the study area. The number was obtained using Purposive sampling technique.

Instrumentation

The instrument used for data collection was the Biology Performance Test on Human Skeletal System (BPTOHSS) and Biology Retention Test on Human Skeletal System (BRTOHSS). BPTOHSS is a researcher-made instrument with 25 multiple choice items. The items were drawn to cover the basic concepts of the skeletal system, axial and the appendicular skeleton, importance of skeleton to man and the joints.

Validation of the Instrument

The instrument was face and content validated by two experts which reduced the initial pool to twenty items.

Reliability of the Instrument: The reliability of the instrument was 0.88.

On the bases of the high reliability index, the instrument was deemed suitable to be used in conducting the study.

Method of Data Collection

Data were collected using Biology Performance Test on Human Skeletal System (BPTOHSS). Students were taught the concept of human skeletal system for four weeks. After the treatment was the administration of the test item. In order to measure students' retention of the concept, the BPTOHSS items were reshuffled and administered to students three weeks after the post-test as retention test.

Method of Data Analysis

The data collected was analyzed using descriptive statistics (mean and standard derivation) and Analysis of Covariance (ANCOVA). The choice of ANCOVA is informed by the use of intact classes. Mean and standard derivation was used to answer the research questions raised. The post-test scores were used as a covariate in measuring students' retention.

RESULTS

Research Question 1: What is the difference in the academic performances of students taught the concept of human skeletal systems using concrete and iconic models?

Table 1: Mean and standard deviation of students' pre-test and post-test cores with instructional models

GROUP	N	PRETEST		POST-TEST		GAIN SCORE
		1	SD ₁	2	SD ₂	
Concrete Model	70	32.62	9.46	57.11	9.00	24.49
Iconic Model	74	24.27	9.62	50.62	8.41	26.35

The summary of results in Table 1 shows that the mean performance gain scores of students taught the concept of human skeletal system using concrete model is 24.49, while that of those taught using iconic model is 26.35. This indicates that students taught using iconic models had a higher gain score than those taught using concrete models.

Research Question 2: What is the difference in the retention scores of students taught the concept of human skeletal system using concrete and iconic models?

Table 2: Descriptive mean and standard deviation of students' pre-test and retention test scores with instructional models

GROUP	N	POST-TEST		RETENTON		GAIN SCORE
		X ₁	SD ₁	X ₂	SD ₂	
Concrete Model	70	57.11	9.00	65.96	8.96	8.85

Iconic Model	74	50.62	8.41	54.45	8.08	3.83
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The summary of result in Table 2 shows that the mean retention gain score of students taught the concept of human skeletal system using concrete model is 8.85, while that of students taught with iconic model is 3.83. This indicates that students taught human skeletal system using concrete model had better retention than those taught using iconic model. This imply that concrete model facilitate retention better than the use of iconic model.

Research Question 3: What difference exists between the academic performances of male and female students taught the concept of human skeletal system using concrete and iconic models?

Table 3: Mean and standard deviation of students' pre-test and post-test scores by gender and treatment

GROUP	N	PRE-TEST		POST-TEST		GAIN SCORE
		1	SD ₁	2	SD ₂	
Male	73	31.45	10.28	57.29	9.00	25.84
Female	71	25.13	9.57	50.19	8.11	25.06

The summary of results in Table 3 indicates that the mean gain scores of male students taught the concept of human skeletal system using concrete and iconic models is 25.84, while that of female students is 25.06. In other words, Male and female students taught the concept of human skeletal system using concrete and iconic models do not differ significantly.

Research Question 4: What difference exists between the retention scores of male and female students taught the concept of human skeletal system using concrete and iconic model?

Table 4: Mean and standard deviation of students' pre-test and retention test scores by gender and treatment.

GROUP	N	POST-TEST		RETENTION		GAIN SCORE
		X ₁	SD	X ₂	SD	
Male	73	57.29	9.00	64.33	9.65	7.04
Female	71	50.19	8.11	55.37	8.63	5.14

In Table 4, the mean retention gain score of male students taught the concept of human skeletal system is 7.04 while that of female students is 5.14. The mean retention gain score of male students is higher than that of their female counterparts.

Testing the Hypotheses

HO₁: There is no significant difference in the academic performances of students taught the concept of human skeletal system using concrete and iconic models.

Table 5: Summary of Analysis of Covariance (ANCOVA) of students' post-test scores classified with instructional models with pre-test scores as covariates.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3990.262 ^a	2	1995.131	33.964	.000
Intercept	24703.055	1	24703.055	420.535	.000
Pre-test	2473.864	1	2473.864	42.114	.000
Group	242.704	1	242.704	4.132	.044
Error	8282.627	141	58.742		
Total	428728.000	144			
Corrected Total	12272.889	143			

a. R Squared = .325 (Adjusted R Squared = .316)

Note: Group = mode of instruction (concrete model and iconic model group)

The summary of results in Table 5 indicated that there is a significant difference in the academic performance of students taught the concept of human skeletal system using concrete and iconic models $F(1,144) = 4.13, p < 0.05$. Therefore, the null hypothesis of no significant difference in the academic performance of students taught the concept of human skeletal system using concrete and iconic model is rejected. This means that there exists a significant difference between the academic performance of students taught the concept of human skeletal system using concrete and iconic models.

HO₂: There is no significant difference in the retention scores of students taught the concept of human skeletal systems using concrete and iconic models

Table 6: Summary of Analysis of Covariance (ANCOVA) of students' retention test scores classified by instructional models with post-test scores as covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	5228.710 ^a	3	1742.903	25.483	.000
Intercept	8522.234	1	8522.234	124.606	.000
Post-test	161.595	1	161.595	2.363	.127
Pre-test	195.019	1	195.019	2.851	.094
Group	2457.532	1	2457.532	35.932	.000
Error	9575.116	140	68.394		

Total	531645.000	144
Corrected Total	14803.826	143

a. R Squared = .353 (Adjusted R Squared = .339)

Note: Group = mode of instruction (concrete model and iconic model group)

The summary of result in Table 6 indicates that the calculated $F(1, 144) = 35.932$, $p < 0.05$ is significant. Therefore the null hypothesis of no significant difference in the retention scores of students taught the concept of human skeletal system is rejected. This implies that there exists a significant difference of students taught human skeletal system using concrete and iconic models. Hence, instructional models have significant relationship with students' retention on biology.

HO₃: There is no significant difference between the performances of male and female students taught the concept of human skeletal system using concrete and iconic models.

Table 7: Summary of Analysis of Covariance (ANCOVA) of students' academic performance scores classified by gender with pre-test scores as covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4383.895 ^a	2	2191.948	39.177	.000
Intercept	27071.057	1	27071.057	483.841	.000
Pre-test	2559.937	1	2559.937	45.754	.000
Gender	636.338	1	636.338	11.373	.001
Error	7888.994	141	55.950		
Total	428728.000	144			
Corrected Total	12272.889	143			

a. R Squared = .357 (Adjusted R Squared = .348)

The summary of the result in Table 7 showed that the calculated $F(1, 144) = 11.373$, $p < 0.05$ is less than 0.05. Thus, it is significant. Therefore, the null hypothesis of no significant difference between male and female students taught the concept of human skeletal system using concrete and iconic models is rejected. Hence, there is a significant difference in the academic performance of male and female students taught the concept of human skeletal system using concrete and iconic models.

HO₄: There is no significant difference in the retention scores of male and female students taught the concept of human skeletal system using concrete and iconic model.

This hypothesis was tested using Analysis of covariance (ANCOVA) of students' Retention scores classified by gender with post-test as covariate.

Table 8: Summary of Analysis of Covariance (ANCOVA) of students' retention scores classified by gender with post-test scores as covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3549.541 ^a	2	1774.771	22.235	.000
Intercept	7589.226	1	7589.226	95.082	.000
Post-test	658.303	1	658.303	8.248	.005
Gender	1577.906	1	1577.906	19.769	.000
Error	11254.285	141	79.818		
Total	531645.000	144			
Corrected Total	14803.826	143			

a. R Squared = .240 (Adjusted R Squared = .229)

The summary of result in Table 8 indicates that the calculated $F(1, 144) = 19.769$, $p < 0.05$ is significant. Therefore, the null hypothesis of no significant difference in the retention scores of male and female students taught the concept of human skeletal system using concrete and iconic models is rejected. Hence, there is a significant difference in the retention scores of male and female students taught the concept of human skeletal system using concrete and iconic models.

The summary of the findings for this study from Tables 1 to 8 is as follows:

- (i) The models used in the study had a significant effect on the academic performance of students in the concept of human skeletal system. Students taught using concrete model had higher mean score than those taught using iconic model.
- (ii) Models had significant effects on the retention scores of students in the concept of human skeletal system. Students taught using concrete models retained better than those taught using iconic model.
- (iii) Gender had significant effect on the academic performance of male and female students in biology when taught the concept of human skeletal system using concrete and iconic models

- (iv) Gender had significant effects on the retention scores of male and female students in biology when taught the concept of human skeletal system using concrete and iconic models.

DISCUSSION

Effects of Models on Students' Academic Performance in Human Skeletal System:

The summary of results in Table 5 indicates that there is a significant difference in the performance of students taught the concept of human skeletal system using concrete and iconic model. As shown in Table 1, the mean academic performance of students taught the concept of human skeletal system using concrete model, 57.11 was higher than that of the iconic model with mean academic performance of 50.62. This result could be due to the ability of the students to manipulate the different models of human skeletal system, hence developing a deeper attachment to the concepts taught. It could also be attributed to the learners' supplemental contact with the variables in real experiences because the principle is seen in action and colours. It is the researcher's belief that the use of concrete model has helped the students to develop confidence in themselves during the teaching/learning process.

The finding of this study is in accordance with the findings of Jiya (2011) who found that teaching-with-analogy enhances students' performance in biology than the lecture method. The finding is also in agreement with the findings of Owolabi (2007) who found that there is a significant influence of models on students' performance in physics. The finding agrees with the finding of Sani (2006) who found that models enhance the performance of students in chemistry more than the conventional method. The finding is also in accordance with Olanrewaju (2012) who found that the students taught using a cooperative learning strategy with models had a higher mean score than the students taught using a cooperative learning strategy without models.

Effects of Models on Students' Academic Retention in Human Skeletal System:

The summary of result in Table 6 indicates that there is a significant difference in the mean retention scores of students taught the concept of human skeletal system using concrete and iconic models. The mean score in Table 4 shows that students taught the concept of human skeletal system using concrete model had a higher mean retention score of 65.96 while those taught using iconic model had a mean retention score of 54.45. The result could be attributed to the use of concrete model, the true picture of what was taught will always reflect in the students' mind each time there is need for it. For knowledge to develop, the acquired materials in the mind need to be preserved in form of images. Therefore, concrete model employed real images which captured the students' mind and helped them retain better. The male students probably retained better than the females because they are more inclined to science related

subjects and have a natural positive attitude to science subjects while the females show negative attitude.

The finding of this study is in line with that of Udogu and Njelita (2010) who found that model (GLM) is very effective in enhancing meaningful leaning and retention among students. The finding is also in accordance with Olanrewaju (2012) who found that there was a higher retention ability by the students taught using cooperative learning strategy with models (CLS+M) than students taught using cooperative learning strategy without models (CLS).

Effects of Gender on Students' Academic Performance in Human Skeletal System:

The summary of the result in Table 7 indicates that there is a significant difference in the academic performance of male and female students taught the concept of human skeletal system using concrete and iconic models. The mean academic performance of male and female students shown in Table 2 indicates that the mean academic performance of male students, 57.29, is greater than that of the female students, 52.19. This may probably be because; the male students are already naturally inclined to scientific and technological fields. Also, male students tend to be more imaginative, creative, and critical while female students believe that science is too difficult and not important for their future. Also, male students are already inclined to science subjects and see it as a necessity, therefore paying serious attention to lessons. The finding of the study agrees with that of Abdu-Raheem (2012) who found that male students achieved better than females in mathematics, science, and social sciences. The finding of the study is also in line with that of Olasehinde and Olatoye (2014) who found that there was a significant difference between male and female students in the overall science achievement.

Influence of Gender on Students' Retention in Human Skeletal System:

The summary of the result in Table 8 indicates that there is a significant difference in the mean retention scores of students taught the concept of human skeletal system using concrete and iconic models. The mean retention scores of male and female students shown in table 6 indicate that the mean retention test of male students, 64.33, is greater than that of the female students, 55.37. This means that the use of concrete model has certain advantages such as; it can easily be manipulated by the students as many times as needed unlike the iconic model. This is because the strategy allowed new materials, especially abstract concepts, to be more easily assimilated with the student's prior knowledge, enabling them to develop a more scientific understanding of the concept. These aid the memory retention resulting in higher performance of the students. The finding of this study is in line with the findings of Udogu and Njelita (2010) and Augustinah and Bolajoke (2014) who investigated the effects of models on senior secondary school students' achievement and retention in Biology. The results of their findings revealed that, there is a significant positive main effect of students' achievement and retention when taught with constructivist learning models. Male students had higher achievement scores than their female counterparts when taught using constructivist learning models. The findings of this study therefore indicate that teaching with concrete model can enhance academic performance and retention of human skeletal system concepts among biology students.

Recommendations

In view of the observations made and their educational implications, the following recommendations are made:

- (i) Since concrete models have been found to improve students' performance, it is recommended that teachers of biology should always adopt concrete models in teaching various concepts in their classroom interactions instead of using iconic models as concrete model reduce abstractions associated with difficult concepts.
- (ii) Teaching and learning materials should be provided by government agencies such as State Governments and the Federal Ministry of Education for effective utilization of teaching with models in the teaching/learning of human skeletal system concept at SSS level.
- (iii) Models help encourage visualization and reorganization of science facts in the learner's cognitive structure; it should therefore be encouraged for teaching in the science classroom
- (iv) Biology teachers should be trained and retrained on the job to adopt the use of concrete models in the teaching and learning of biology. Training of biology teachers could be done by the Government or relevant professional bodies like Science Teachers Association (STAN) through seminars, workshops and conferences.
- (v) Teachers should select models that are familiar to students because such models are motivational to students, avoid time wastage, and are easy to use by the teachers.

Conclusion

Based on the findings from the study, it is hereby concluded that concrete model as a teaching strategy facilitates students' academic performance in human skeletal system concept better than the use of iconic model. Gender is not a significant predictor of students' academic performance or retention in biology.

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