

Effects of Constructed Model of Human Urinary System on Secondary School Biology Students' Academic Achievement and Retention in Minna, Niger State, Nigeria

BABAGANA, M., CHADO, A. M. and GIMBA, R. W.

Dept. of Science Educ., Federal Univ. of Technology, Minna
mohd.bgana@futminna.edu.ng (+2348066553470)
chadoamina@gmail.com (+2348035965345)
ramatu.gimba@futminna.edu.ng (+2348032853603)

Abstract

This study investigated the effect of Constructed Model of Human Urinary System on Senior Secondary School Biology Students' Academic achievement and Retention in Biology in Minna Metropolis. A pretest posttest control quasi experimental design was adopted for the study. Four research hypotheses were formulated and tested at 0.05 level of significance. Simple random sampling was used to select three secondary schools in Minna Metropolis which were randomly assigned to experimental and control group. A total of 95 senior secondary school II students were used for the study. Pretest was given to the two groups before the treatment to know their entry behavior. Posttest was given to the two groups after being taught Mechanism of Urine Formation for four consecutive periods to test for their academic achievement. A week after the posttest, post posttest was given to test for their Retention on the concept being taught. The results shows that the group taught with Constructed Model (experimental group) performed better and had good retention than students taught with Conventional Lecture Method which is the control group. Government, Schools management and teachers should realize that teaching with constructed models enhances learning. Education sector should endeavor to organized seminars, conferences and workshop on how to produce constructed models or inexpensive instructional materials for use in schools so as to enhance students' academic performance and retention.

Introduction

Biology is derived from the Greek word bio -life and logia -study of. It is a natural science with the study of life and living organism, including their structure, function, growth, evolution, distribution and taxonomy (Okwo and Iliyah 2012). Sub disciplines of biology are defined by the scale at which organism are studied, the kind of organisms, the method used to study them: Biochemistry botany, zoology, cell biology, evolutionary biology. Wikipedia (2015) also said Biology has been playing an important part in humans day to day activities because of its great varieties in biology as one of the most interesting

subject, it is an important course especially for science students since it will affect everyone's future (Ibrahim, 2014). It is very important for us to understand how cells and organism works, it involves the study of life and it is important as it tells us about the natural world. Biology tells us about our body anatomy and physiology that helps us develops cures and treatment for many diseases such as malaria, typhoid, fever, dysentery etc. Biology as a science helps human life in many ways such as; cross-breeding, blood transfusion, drug product, and antibiotics among others. It also tells us about plants and how they can be beneficial to human life such as; forest, domestics uses and industrial uses, erosion control of greenhouse effect (Okwo and Otubah, 2007).

Constructed model are not the real world but they are guidelines or set of strategies on which the approach to teaching by instructor based Ibrahim (2014). Effective instructions are based on learning theories which explains how people who believe in theories learn new ideas and concepts. Constructed models also explain the relationship and differences between ideas or concepts or information that already exist and the new ones (MEST, 2006). They are instructional materials that assist learners in the retention and usage of abstract symbols for a more desirable outcome. The government has recognized that it is important to incorporate and intensify the use of instructional materials at all levels of education and that all schools should be equipped with instructional materials for effective teaching and learning (NPE,2004). Instructional materials including textbooks, constructed models, educational media, computer software etc. represent fundamental resources for school for enhancing instruction, furthering the pursuit of knowledge and providing experiences of educational significance for class, group or individual students, (Nwoye,2002).

Sherifah (2014), investigated the effect of constructed model of digestive system of birds on academic performance and retention of biology students in Bida Metropolis using a quasi-experimental design and population of all senior secondary school students in Bida Local Government Area of Niger State. Sixty (60) biology students were selected using simple random sampling technique and were divided into two groups of thirty (30) students out of which fifteen (15) male fifteen female students were selected per group using stratified random sampling technique. The study showed that constructed model helped to improve students performance in the experimental group significantly as compared to those taught with the traditional lecture method.

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hundred and thirty (130) biology students were selected using simple random sampling technique and were divided into two groups of sixty five (65) students out of which thirty five (35) male thirty(30) female students were selected per group using stratified random sampling technique. The result shows that the students taught with the constructed model performed better and retained the concepts for a long time as compared to those taught with the traditional lecture method.

Gender achievement and retention have also been identified by quite number of research findings. Mohammed (2000) said, the recurring theme among educators especially science educationists and society at large is gender equity or gender friendliness in teaching and learning. Gender difference is the separation of male and female in such a way that one is preferred to another one (Jacob, 2000). Most studies show that, average girls do better in school than boys. Girls get higher grade and complete school at a higher rate compared to boys (Jacob, 2002). Standardized achievement test also showed that female are better at spelling and perform better on test of literacy, writing and general knowledge.

Statement of the Problem

Research findings have shown that the students enrolment into the subject Biology have been on the increase (Nsofor, 2010). This increase in enrolment is also been accompanied or proportionate to the performance of the students. West African Exam Council (WAEC) and National Examination Council (NECO) result of 2013 showed that many students failed Biology. The chief Examiners reports specifically identified the functions and role of Nephron to be poorly answered by the students. However many teaching strategies have been employed to arrest this situation such as the use of CAI,CBI, CMI amongst others but the poor achievement of students persist Based on the above fact the researcher felt that a more student centered approach which requires the learner to actively participate in the teaching and learning process be adopted for the teaching of Biology. The strategy which may salvage the problem may be the use of Constructed Model. Therefore, the study intends to investigate the effect of constructed model on students' achievement and retention of Biology in Minna Metropolis.

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 alpha level of significance

HO₁: There is no significant difference in the mean achievement scores of students taught with Constructed model of Human Urinary System and those taught with Conventional Lecture Method.

HO₂: There is no significant difference in the mean achievement scores of male and female students taught with Constructed Model of Human Urinary System.

HO₃: There is no significant difference between the mean retention scores of studentstaughtwith Constructed Model of Human Urinary System and those taught using Conventional Lecture Method

HO₄: There is no significant difference between the mean retention scores of male and female students taught with Constructed model of Human Urinary system.

Method

A pretest-posttest control Quasi- experimental design was adopted for the study. This was considered more suitable for this study because it establishes a cause and effect relationship between the independent and dependent variables of the study (Adeyanju, 2003). The entire population of the students in Minna Metropolis formed the target population for the study. The total population of SSII students in Minna in 2014-2015 session is 5,490 students. The choice of SS11 class used for the study was based on WAEC Chief Examiner's report of 2013 which described the mechanism of urine formation as a difficult concept. A total of 95 seniorsecondary school students in their intact classes were used. The selected schools were randomly assigned to experimental and control groups.

The two research instruments used for the study were Constructed Model of Urinary Nephron (Treatment Instrument) and Biology Achievement Test (BAT) as the test instrument. The test instrument was developed by the researcher in line with the content of the topic treated. Each question in the BAT has five optional answers A-E with only one right answer. The items were used for pretest, posttest and retention test. But when the items were used for pretest they were reshuffled before using them as posttest and the same procedure adopted before administration for retention test to create an impression at any point in time as if different from each other.

The model and BAT were validated by experts in the field of Educational Technology and Science Education specialists in FUTMinna. The BAT items were also validated by Secondary School Biology tutors who the ones are teaching the subject, but these tutors were drawn from schools not in the study

area to avoid leaking of questions to students before the treatment. The model and the items were considered valid and thus were used for the study.

To determine the reliability of the BAT items, a pilot test was conducted in a secondary school outside the study area; Day Secondary School, Bosso, Minna of Niger State. BAT items were administered to Ten (10) students and the scripts were collected and marked. After an interval of one week the same test was re-administered to the group of students previously used and the scripts collected and marked, the two test scores were collated and analyzed. The analysis of the data was done using Pearson Product Moment Correlated Coefficient Formula (PPMC) and $r = 0.85$ was obtained. This indicated that the items are reliable and was used for the study. On the collection of data, Pretest was used to determine the previous knowledge of the students before the treatment. Posttest was used in collecting data on achievement and delayed posttest for retention. The experimental group which is the Model Teaching Group (MTG) was taught with the model of Human Urinary System for four subsequent lessons, lasting for 40mins each. The control group which is the Conventional Teaching Group (CTG) was taught without the use of constructed model of Human Urinary System for the same number of period and minute. At the end of the teaching, posttest was administered to the two groups, the posttest questions were reshuffled to look different from the previous ones used for pretest. Thus, after one week another test was given to the same group of students and the questions were also reshuffled to appear different from the posttest questions. The data were collected and analyzed. The mean, standard deviation and t-test statistics were used in analyzing the pretest, posttest and retention test scores. Statistical Package for Social Science (SPSS) version 20.00 was used to analyze the data obtained.

Result

The data obtained from the study have been analyzed and presented using mean, standard deviation and t-test statistical analysis.

Pretest Result

Table 1: t-test Analysis of Pretest Scores for both Experimental and Control Groups

Groups	N	Mean	SD	Df	t	p
Control	50	11.40	6.06	93	-1.78 ^{ns}	0.08
Experimental	45	9.44	4.42			

The result in table 1 shows t-test comparison between the mean achievement score of experimental group and control group in the pretest. The mean scores of control group is 11.40 and standard deviation (SD) 6.064 while the mean scores of experimental group 9.44 and the standard deviation is 6.064 with marginal mean difference of 1.96. This means that there is no significant difference in the scores ($t = -1.778$, $df=93$, $p < 0.05$). Hence, the study indicated that, the score of both control group and experimental group were at the same level before the treatment with constructed Model of the Nephron. Thus, it is considered satisfactory for the research work.

Hypotheses

HO₁: There is no significant difference in the mean achievement scores of students taught Human Urinary System with constructed model of Nephron and those taught with Conventional Lecture Method.

**Table 2: t-test Analysis of the Achievement (Posttest)
Scores for Experimental and Control Groups**

Groups	N	Mean	SD	Df	t	p
Control	50	24.20	5.28	93	10.49*	0.00
Experimental	45	34.44	4.09			

Significant at $P < 0.05$ level.

Table 2 shows the t-test comparison between the mean achievements score of students taught with Constructed Model of Nephron and students taught with Conventional Lecture Method. The mean scores of control group is 24.20 and standard deviation (SD) is 5.28 while the mean score of experimental group 34.44 and standard difference is 4.09 with marginal mean difference of 10.20 with ($t=10.49$, $df=93$, $P < 0.005$). The result of the study shows that there is a significant difference in the mean achievement score of students taught Human Urinary System with Constructed Model of Nephron and those that were taught with Conventional Lecture Model. Hence, the null hypothesis that stated that there is no significant difference in the mean achievement score of students taught Human Urinary System with constructed model of Nephron and those taught with Conventional Lecture Method is therefore rejected. The significance difference between the control group and experiment group on their achievement score is in favour of experimental. This showed that the features of the model enhance the learning achievement of the students in the experimental group.

HO₂: There is no significant difference in the mean achievement scores of male and female students taught Human Urinary System with Constructed Model of Human Nephron and those taught with Conventional Lecture Method

Table 3: t-test Posttest Analysis of Mean Achievement Scores of Male and Female Students in Experimental Group

Groups	N	Mean	SD	Df	t	p
Male	26	34.15	4.135	43	-5.53 ^{ns}	0.58
Female	19	34.84	4.100			

NS: Not Significant at $P > 0.05$ level

Table 3 shows the t-test comparison between the mean achievement scores of male students and mean score of female students' achievement which were taught Human Urinary System with constructed Model of Human Nephron). The mean score of male is 34.15 and the standard deviation (SD) is 4.135 while mean score of female is 34.84 and the standard deviation (sd) is 4.100 with marginal mean 0.69 and ($t = -5.53$, $df = 43$, $p > 0.05$). The result of the study indicates that there is no significance difference in the mean achievement score of male and female taught Human Urinary System with Constructed Model of Human Urinary Nephron. Hence the null hypothesis stated above says that there is no significance difference in the mean achievement scores of male and female students taught Human Urinary System with Constructed Model of Human Nephron is thereby accepted. This means that there is no significance difference between the two groups on their respective achievement. This showed that the characteristics of the model exerted the same effect on the learning of the concept by the both sexes in equal proportion.

HO₃: There is no significance difference between the mean retention scores of students taught Human Urinary System with Constructed Model of Human Nephron and those with Conventional Lecture Method.

Table 4: t-test Analysis of mean Retention Score of Experimental group and Control group

Group	N	Mean	SD	Df	t	p
Control	50	19.18	1.072	93	18.58*	0.00
Experimental	45	26.38	2.39			

NS: Significant at $p < 0.05$ level.

Table 4 shows the t-test comparison between the mean retention score of students taught Human Urinary System with Constructed Model of Human Nephron and the mean score of those taught with the conventional lecture method of teaching. The mean scores of control group is 19.18 and the standard deviation (SD) while

experimental mean score is 26.38 and the standard deviation (SD) is 1.072 with (t -test=18.593, df =93, p <0.05). This result of the study indicates that there is significant difference in the mean retention score of the students taught Human Urinary System with Constructed Model of Human Nephron and those taught with Constructed Lecture Method of teaching. Hence the null hypothesis stated above states that there is no significant difference between the mean retention scores of students taught Human Urinary System with Constructed Model of Human Nephron) and those taught with Conventional Lecture Method is thereby rejected. There is significant difference between the control group and experimental group in favor of experimental group.

HO₄: There is no significant difference between the mean retention of male and female students taught Human Urinary System with Constructed Model of Human Nephron and those taught with conventional Lecture Method.

Table 5: t-test Analysis of Mean Retention Scores of Male and Female Students in Experimental Group

Group	N	Mean	SD	Df	t	p
Male	26	26.38	1.06	43	0.15 ^{ns}	0.88
Female	19	26.33	1.14			

NS: Not Significant $p > 0.05$ level.

Table 5 shows the t-test comparison between the mean retention score of male students and female students taught Human Urinary System with constructed Model of Human Nephron. The mean score of male is 26.38 and the standard deviation (SD) is 1.061 and the mean score of female is 26.33 and the standard deviation (SD) is 1.138 with (t =0.153, df =43 p >0.05). This result indicates that there is no significant difference. Therefore, the above stated hypothesis that there is no significant difference in the retention score between the male and the female students' taught Human Urinary System with Constructed Model of Human Nephron is accepted. This showed that the characteristics of the model exerted the same effect on the learning of the concept by the both sex in equal proportion.

Discussion

Findings show the comparison between the academic achievement of control group and experimental group on pretest to examine their level of understanding before pretest questions was administered to them. The test was the 10 objectives item in Biology Achievement Test (BAT). The students were given 15minutes to do the test. The test was given to examine the academic achievement of control group and experimental group. However the result shows that the t-value

calculated is -1.778 which less than the t-value tabulated is 1.728 at 0.05 level of significant and p-value computed 0.079 is greater than 0.05 level of significant which is not significant. Therefore, the two groups that is the control group and experimental group were at the same level on their entry behavior of Biology subject and thus consider satisfactory for the research work.

Findings show the comparison on the achievement of control group and experimental group after the teaching of Human Urinary System. The t-value calculated which is 10.494 is greater than the t-value tabulated at 0.05 level of significant and p-value computer is 0.000 is less than 0.05 level of significant. The result is therefore showed, that Experimental group performed significantly better than the control group in the academic achievement. Therefore the use of Constructed Model increases and enhances learning more than the Conventional Lecture Method at Senior Secondary School level in Biology students in Minna Metropolis. In support to this findings, Yaki, (2012), in the journal of Arts and Science (JOLAE, 2012), noted that experimental group performed better than the control group in the academic achievement. In contrary to the previous finding, Nwosu (2002) noted that there is no significant difference in the academic achievement between experimental group and control group when model, diagrams, and styles were used in teaching.

Findings show the comparison between male and female achievement in the experimental group. To examine if there is any significant gender differences between the male and female. The t-value calculated is -5.53 which less than 0.05 level of significant is. And the p-value computed is 0.583 which is greater than 0.05 level of significant. This result shows that there is no significant difference in male and female academic achievement of the experimental group when constructed model of Human Urinary System was used in the teaching. This result agree to the view of Awoniyi (2000) noted that gender do not have any influence on learning achievement of students when both exposed to the same treatment, In contrary to the previous finding, Okwo and Otubah, (2007) and Gambari (2004) noted that experimental male did better that female students in the group when they were taught with instructional materials.

Findings show the comparison between retention of control group and experimental group using post posttest question. The t-value calculated was 18.597 is greater than t-value tabulated at 0.05 level of significant. Also the p-value computed is 0.000 which is less than 0.05 level of significant which means that the experimental group performed better than the control group in the learning retention. This means that constructed model enhances and facilitates learning retention more than the Conventional Lecture Method in Senior Secondary School Biology students in Minna Metropolis. This finding supports

Journal of Arts and Education, (JOLAE, 2012), which stated that there is significant difference in the mean achievement scores of the students.

Findings show the comparison between male and female retention in the experimental group. The t-value calculated is 0.153 which is greater than 0.05 level of significant and p-value computed is 0.879 which is greater than 0.05 is not significant. This indicated that no gender differences exist in the learning of the experimental group.

Conclusion

In conclusion, the findings from the research reveal that, the use of Constructed Model in the teaching of Biology is more effective, facilitative and enhances perception, creativity and performance of students. The findings also reveal that, there is no gender differences in achievement and retention of students taught with the use of Constructed Model.

Recommendations

In view of the findings of this research work, the following recommendations were suggested for better achievement in Biology.

- (1) Biology teacher should abide with the use of appropriate visual Instructional Material in teaching, in order to facilitate and draw attention of students during teaching and learning process. This will help to improve performance.
- (2) Effective use of teaching aids by Biology teacher should leads to affective teaching that can lead to attainment of both grades of students achieving good examination grades and positive behavioral change.
- (3) The school management should organize in-service training like seminars, workshops, conferences etc. for teachers so that their ability may be wide and making the teacher to be more effective.
- (4) Government, Education Administrator of various schools should support and encourage the creativity of science teacher by giving some incentive for the production of teaching material which will improve science and technology in Nigeria.
- (5) There should be reinforcement of teacher dedication to work through price giving or promotion.

References

- Adeyangu, J. L. (2003). Teacher perception of the effect and learning aids in teaching. Jos; Challenge press (Nig.) limited.
- Augustina. D. J. (2015) Construction and validation of human heart model for teaching and learning in secondary schools in Edati Local Government Area of Niger State, Nigeria.
- Awoniyi, A.S. (2000). Sex difference in an academic performance. Nigeria Journal of Gender and Development. 1 (82) 8.
- Federal Ministry of Education, (2013). National Policy on Education
- Gambari, A.I. (2004). The development of computer aided instruction (CAI) software for individualized instruction in Physics in Senior Secondary School in Niger State. Unpublished M. Tech. Thesis FUTMinna.
- Ibrahim, O.S., (2014). Constructed and validation of digestive System model of fowl on academic performance and retention of student of biology in minna metropolis, Niger State. Unpublished M.Tech..FUTMinna.
- Ibrahim, S.A. (2000). Instructional materials. Journal-Teacher Periscope of NUT Kogi State. Wing.11 (2) 27-29.
- Jacob, J. M. (2000). Gender and academic Achievement. Retrieved from <http://www.education.com/reference/article/genderacademicachievement/>
- MEST, (2006). Instruction design model learning technology service, NC State University. Retrieved from <http://www.eduwikiunige.ch/en/instructionalmediadesign/>
- Mohammed, N. (2011). Effect of diagrams, on learning achievement among biology students in Senior Secondary Schools in Minna. Unpublished B.TechFUTMinna.
- Mohammed, S.A. (2000). Assessment of female students performance in selected science courses. A case study of federal polytechnics bida. Nigeria Journal of Gender and developmental 1 (1 & 2) 61-64.

- Nwoye, Z. I. (2002). Human resources development in biology and economics implication. STAN Journal (47th).
- Nwosu, E.C. (2002). Teaching and learning resources in chemistry at senior secondary school Certificate Exam. The way forward, 43rd STAN. Journal. Heinemam Education Book plc
- Nsofor, C.C. (2010). A study of prior knowledge and new knowledge of SS2 Biology students in Relation to Inheritance. Unpublished M.Sci (Edu) Thesis, University of Jos, Nigeria.
- Okwo, F.A. & Iliya, T. (2012). Effect of position of diagrams and cognitive styles on Biology achievement of pre-national diploma students. Journal of Science Teacher Association of Nigeria 39 (1 & 2) 88-93.
- Okwo, F. A. & Otubah, S. (2007). Influence of gender and cognitive style on students achievement in Physics essay test. Journal of the Science Teachers Associate of Nigeria. 42 (1 & 2) 85-88.
- Sherifah, R. O. (2014) Construction and validation of digestive system model of fowl on academic performance and retention of students of biology in Bida metropolis, Niger State, Nigeria.
- Yaki, A. A., Babagana, M. & Rabiu, M. B. (2012), Enhancing the Quality of Science Education Graduates through Innovative Instructional Approach. A Journal of Arts and Education (JOLAE). IBB University, Lapai, Niger State, Nigeria. 6 (2) 14-23.