Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.9, No.12, 2018

Influence of Virtual Reality and Flow Chart on Biology Students' Academic Achievement on Circulatory System in Uyo Municipality, Akwa Ibom State, Nigeria

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Abstract
This study investigated the influence of virtual reality and flow chart on biology students' academic achievement on circulatory system. Non- randomized pre-test, post-test control group design was used for the study. Study sample was 121 SS3 biology students drawn from Uyo Municipality of Akwa lbom State, Nigeria. Simple random sampling technique was used for the study. Two research questions and two hypotheses were tested. The instrument for data collection was Biology Achievement Test (BAT). A reliability index of 0.87 was determined using test-retest approach. The results showed that gender was not a strong determinant of students' achievement in biology. It was recommended among others that, parents and biology teachers should encourage both male and female students towards excellence in biology.
Keywords: Virtual reality; Flow chart; Biology Academic Achievement; Circulatory system

1.1 Introduction

Biology is one of the basic science subjects in Nigerian secondary school education system and it is core subject for science students. It is therefore a stepping stone for millions of secondary school students for successful career in any area of science. The knowledge of biology thus promotes acquisition of knowledge, prevent and cure diseases, gives us ideas about our genetic make-up, all geared toward improving the quality of life and conceptual review has shown that virtual reality and flow chart as instructional resources are indispensable instructional components for the teaching and learning of biology. Virtual reality and flow chart can make teaching more effective with accurate and sufficient information that supports the curricula content as well as more efficient by reducing the time to deliver instruction. In addition, they can increase instructional appeal so that students are more likely to devote time and energy to the learning task and review what they learned later. Virtual reality and flow chart can also increase students' motivation to learn and make learning interesting.

1.2 Virtual Reality

Virtual Reality is the creation of simulation of a real world experience that a person can enter and leave at any time using technology. According to Jackson (2015), Virtual Reality (VR) is the use of computer technology to create a simulated environment. Unlike traditional user interfaces, VR places the user inside an experience. Instead of viewing a screen in front of them, users are immersed and able to interact with 3D worlds. By simulating as many senses as possible, such as vision, hearing, touch, even smell, the computer is transformed into a gatekeeper to this artificial world. Virtual reality helps students to understand invisible conceptual worlds of science through animation which can lead to more concrete understanding of scientific concepts. Virtual reality as an instructional material also encourage the development of the mental capability of the students, and it best suited where mastery is required of subjects that students perceive as difficult, abstract or interesting (Jackson, 2015). Virtual reality do not only allow learners to construct and manipulate screen "objects" for exploring underlying concepts, but they also provide learners with the observation and manipulation tools necessary for exploring and testing hypotheses in the simulated world. According to Umur, and Xing (2017), virtual reality allows learners to visualize abstract concepts and link them to prior knowledge thereby fostering conceptual learning. Students interacting with an instructional simulation gain a better understanding of a real system. This interactivity provides opportunities for students to modify their mental models by comparing the outputs of the model with their expectations.

1.3 Flow Chart

Flow Chart is an instructional resource that has the potential to address the problems of effective teaching and learning in biology. Flow chart is a diagram, picture or graph which is intended to make information easier to understand. It can be used for real objects and specimens where the real objects and specimens are not readily available or accessible. They are instructional resources whose primary functions are to facilitate the teaching of

skills, facts, concepts, principles, generalizations, values and attitude in science (Gredler, 2012). According to Arlidge, Thanukos and Bean (2017), flowchart represents a concept in science as a dynamic, non-linear process with many feedback loops centered on the fundamental activity of science and testing ideas with evidence. It emphasizes routes that one can take into a scientific investigation, as well as the process's reliance on both a community and communication, while visually reminding users of the ways that science benefits society and that the needs and interests of society can stimulate science.

The use of flow chart in teaching is very important to biology teachers and students for a number of reasons; It focuses the attention of students on the concept being taught, helps to engage students on the learning task, stimulates the interest of the students in the learning process and makes them positively disposed to the subject matter, help students to interact with the subject matter at the semi-concrete rather than at an abstract level and also help the teacher to achieve the lesson objectives. Therefore, a good science teacher should be able to guide his students to obtain accurate information from flow charts because students may forget the topic of the lesson but will not forget the illustrations used in demonstrating exercises such as circulatory system.

1.4 Circulatory System

Circulatory System is defined as the collection of organs and structures (such as the heart and blood vessels) that enhance the movement of blood round the body. The system is responsible for the flow of blood, nutrients, oxygen and other gases, and as well as hormones to and from cells. An average adult has 5 to 6 quarts (4.7 to 5.6 liters) of blood, which is made up of plasma, red blood cells, white blood cells and platelets.

Blood vessels are tubes within the body that aid in the transport of blood between the heart, lungs, other parts of the body and Cells. They are grouped into three categories, namely: artery, capillaries and vein. The artery carries oxygen-rich blood away from the heart and breaks up into smaller units called arterioles to organs and tissues. The capillaries act as a junction that joins the arterioles and venules together. The veins join up from the venules and carry oxygen-poor blood back to the heart.

Heartbeat: The heartbeat is also associated with circulatory system. It is caused by alternate contraction and relaxation of the four muscular chambers of the heart. The heartbeat occurs in two (2) stages, which are diastole and systole. Diastole: This is the first stage of the heartbeat during which the two auricles contract, creating a high pressure in the blood contained in them. The pressure causes the biscupid and triscupid valves to fold downward into the ventricle allowing blood to flow from the two auricles into the two ventricles. Systole: This is the second stage of heartbeat which involves the contraction of the two ventricles of the heart and these results in blood being forced into the aorta and pulmonary artery out of the heart (Michael, 2008). The following are the types of circulatory system: closed and open circulatory system, single and double circulatory system, pulmonary and systemic circulatory system which can be taught to both male and female students.

1.5 Gender

Gender refers personal identification associated with male and female with a particular role in society. Sparks (2013) saw gender as a range of physical, mental and behavioural characteristics pertaining to and differentiating the masculinity and feminity of an individual. In the process of learning science-based subjects, some researches show superiority of male over female students and others show superiority of females over males. It influence on student' academic achievement in sciences including biology from the various studies cited indicated conflicting and inconclusive findings. Researchers found that there exist a gender imbalance existing which is a concern for men and women, practitioners, policy makers and parents. For instance, Etiubon and Udoh (2016) opined that in a classroom setting where students are actively involved in an interactive lesson with the teacher, there will be no difference in their academic performance. Raimi (2010) also opined that gender is not a significant factor to be associated with students' performance. If given equal opportunity with the right teaching and learning process, male and female students will achieve equally**.** The observation agrees with Etiubon and Udoh (2016) which showed no significant difference in gender on students' academic performance in biology when taught solubility using practical activities and manuals. Olasheinde and Olatoye (2014) also found that there was no significant effect on gender with regards to students' achievement in science. Sparks (2013) posited that when students are given practical tasks to carry out in science, the sex of the students was a non-significant contributor to their academic performance. On the contrary, Etiubon (2011), Okwo and Otubah (2007) observed that female students performed significantly better than their male counterparts in chemistry and physics but Ekeh (2004) observed that male students performed significantly better than their female counterparts in mathematics. Oludipe (2012) also contend that male students achieve higher than their female counterparts in science. There are still varied viewpoints as well as different conclusions on gender and academic

performance. Indication on gender differences on students' academic performances varies among gender in the science subjects. Based on the inconclusive findings from researchers, this study on the influence of virtual reality and flow chart on biology students' academic achievement on the concept of circulatory system aims at finding out whether virtual reality and flow chart will discriminate against sexes (gender).

2.0 Statement of the Problem

Gender issues have been focused upon because of their significance in the development of any nation. The desired abilities for all males and females students to live useful lives in a scientific and technological world is an indication to produce a labour force that will cope with the demands of the 21st century. Researches show that female students are not having maximum benefit from classroom interactions because teachers tend to provide more opportunities for boys to perform science activities. Female students are not also encouraged to go into science and science related careers as the boys and these created gender imbalance. This poses serious challenges to the development of science education in Nigeria. It therefore becomes inevitable now that high premium is placed on science and technology as the bedrock of national development and advancement to investigate the influence of virtual reality and flow chart on biology students' academic achievement on the concept of circulatory system.

2.1 Research Objectives

The objectives of this study are outline as follows:

1. To determine the academic achievement of male and female biology students taught circulatory system using virtual reality.
2. To assess the academic achievement of male and female biology students taught circulatory system with flow chart.

2.2 Research Questions

The following questions were raised to guide the study.

1. What difference exists in the achievement of male and female biology students taught circulatory system using virtual reality?
2. What difference exists in the academic achievement of male and female biology students taught circulatory system with flow chart?

2.3 Research Hypotheses

The following null hypotheses were formulated to guide and direct the study and they were tested at 0.05 level of significance.

1. There is no significant difference in the academic achievement of male and female biology students taught circulatory system using virtual reality.
2. There is no significant difference in the academic achievement of male and female biology students taught circulatory system with flow chart.

2.4 Methodology

The design used for the study was pre-post post-test control group design. The population for the study comprised all Senior Secondary Three (SS3) biology students in the thirteen (13) public co-educational secondary schools in Uyo Municipality during the 2016/2017 session. The size of the population was two thousand, eight hundred and fourteen (2,814) students. Female students were one thousand, six hundred and thirty five (1,635) and male students were one thousand, one hundred and seventy nine (1,179). Two intact classes were randomly selected from the thirteen (13) public co-educational secondary schools in Uyo Municipality during the 2016/2017 session. The intact classes were randomly assigned into experimental group (virtual reality) and control group (flow chart).

The study sample was One hundred and twenty one (121) Senior Secondary Three (SS3) biology students (male and female) for 2016/2017 session from two (2) secondary schools in Uyo Municipality of Akwa Ibom State. Simple random sampling technique was used to select the classes for the study. A total of fifty one (51) male and seventy (70) female students were selected for the purpose of treatment, analysis and discussion.

Sixty- two (62) students for experimental group and fifty- nine (59) students for the control group were used and these made the total sample to be One hundred and twenty one (121).

The instrument used for data collection was Biology Achievement Test (BAT) on Circulatory system. This was a 25 multiple-choice items designed by the researchers on the concept of Circulatory system. Each item had four (4) options A, B, C and D with only one correct answer after validation. The questions were drawn mostly from past WAEC, NECO and JAMB examination question papers. It was used to determine the achievement of students on the concept of Circulatory system in biology when taught with virtual reality and flow chart.

The draft of the instrument, Biology Achievement Test (BAT) on Circulatory system with thirty-five (35) items was submitted for validation to two (2) lecturers from the department of Science Education and an expert of Test and Measurement, all from the University of Uyo and also two (2) biology teachers from the selected secondary schools for face and content validation. The evaluators' were required to look at the appropriateness and content coverage of the items and provide necessary opinions, suggestions and corrections. All their various corrections and comments made were incorporated into the final draft of the research instrument. From the evaluators' suggestions and comments, the final draft of twenty-five (25) questions was produced.

The instrument was trial tested on 30 students in a school from the population that did not form part of the sample. This was done to establish the reliability. The test retest method reliability method was used. The instrument was administered twice to the same population giving a period of two weeks within the first and second administration. Data obtained were analyzed using Pearson's Product Moment Correlation (PPMC). The result showed that, BAT had a reliability of 0.87. On the basis of the high index, the instrument was considered reliable and suitable in conducting the research. The regular biology teachers from the two schools were used as research assistants. Students in the experimental group were taught circulatory system using virtual reality while those in the control group were taught the same concept with flow chart. The teaching lasted for three weeks for both groups. After teaching, the Biology Achievement Test (BAT) on circulatory system was administered to both groups. The scripts were collected, marked and recorded. The data collected were analyzed using descriptive statistics (mean and standard deviation), and Analysis of Covariance (ANCOVA) at 0.05 level of significance.

3.0 Results

Research Question One: What difference exists in the academic achievement of male and female biology students taught circulatory system using virtual reality?

Table 1:
Mean and Standard Deviation Scores of Male and Female Biology Students' Pre-test and Post-test Performance Taught Circulatory System with Virtual reality

Gender	N	Pre-test		Post-test		Mean Gain
		$\overline{X}_1$	SD_1	$\overline{X}_2$	SD_2	
Male	27	20.15	4.50	67.26	5.33	47.11
Female	35	18.51	4.56	70.00	6.19	51.49

In Table 1, the results shows that male biology students had a mean gain of 47.11 and their female counterparts had a mean gain of 51.49. The result indicated that female biology students achieved better than their male counterparts when both groups were taught circulatory system using virtual reality

Hypothesis One: There is no significant difference in the academic achievement of male and female biology students taught circulatory system using virtual reality.

Table 2:
Summary of Analysis of Covariance (ANCOVA) of Students' Academic Achievement Scores Classified by Gender with Pre-test as Covariate taught with Virtual reality

Source	Sum of Squares	Df	Mean Square	F	Sign at p < .05	Decision
Corrected Model	125.20[b]	2	62.60	1.82	.171	NS
Intercept	13991.62	1	13991.62	406.56	.000	*
Pre-test (covarate)	10.71	1	10.71	0.31	.579	NS
Gender	123.49	1	123.49	3.59	.063	NS
Error	2030.48	59	34.42			
Total	295684.00	62				
Corrected Total	2155.68	61				

* = Significant at P < 0.05 alpha
NS = Not significant at .05 level of significance

As shown in Table 2, the calculated P-value .063 of gender is greater than alpha level .05. Therefore, null hypothesis is retained. This implied that there is no significant gender influence on the academic achievement of students taught circulatory system using virtual reality

Research Question Two: What difference exists in the academic achievement of male and female biology students taught circulatory system flow chart?

Table 3:
Mean and Standard Deviation Scores of Male and Female Biology Students' Pre-test and Post-test Scores Taught Circulatory System using Flow chart.

Gender	N	Pre-test $\overline{X}_1$	SD_1	Post-test $\overline{X}_2$	SD_2	Mean Gain
Male	24	20.15	4.50	59.78	4.85	39.63
Female	35	18.51	4.56	60.00	4.45	41.49

Result of data analysis in table 3 reveals that male biology students had a mean gain score of 39.63 while their female counterparts had a mean gain score of 41.49. The results indicated that female students achieved better than their male counterparts when both groups were taught using flow chart.

Hypothesis Two: There is no significant difference in the academic achievement scores of male and female biology students taught circulatory system using flow chart

Table 4:
Summary of Analysis of Covariance (ANCOVA) of Students' Achievement Scores Based on Gender Using Pre-test as Covariate taught using Flow chart

Source	Sum of Squares	Df	Mean Square	F	Sign at p < .05	Decision
Corrected Model	1.54[b]	2	0.77	0.04	.965	NS
Intercept	11420.13	1	11420.13	525.62	.000	*
Pre-test (Covarate)	0.78	1	0.78	0.04	.850	NS
Gender	0.48	1	0.48	0.02	.882	NS
Error	1281.88	59	21.73			
Total	223764.00	62				
Corrected Total	1283.42	61				

* = Significant at P < 0.05 alpha
NS = Not significant at .05 level of significance

As shown in Table 4, the calculated P value .882 is greater than alpha level .05. Therefore, null hypothesis two cannot be rejected. This implied that there is no significant gender influence on the biology students taught circulatory system using flow chart.

3.1 Discussion of Findings

Findings from the results indicated that there was no significant influence between the academic achievement scores of biology students taught the concept of circulatory system using virtual reality and flow chart as instructional resources. This may have resulted from the interest developed for the virtual reality and flow chart thereby enhancing active participation of male and female students in classroom which enables them achieve better in their lesson. The virtual reality and flow chart may have encouraged both male and female students to harness their intellectual abilities, and further develop same during the teaching and learning process. This is why Umur and Xing (2017) opined that virtual reality helps students to understand invisible conceptual worlds of science through animation which can lead to more concrete understanding of scientific concepts. This finding corroborates with the findings of Jackson (2015) who said that virtual reality as an instructional material encourage the development of the mental capability of the students, and it best suited where mastery is required of subjects that students perceive as difficult, abstract or interesting. Similarly, according to Gredler (2012), the use of flow chart in teaching focuses the attention of students on the concept being taught, helps to engage students on the learning task, stimulates the interest of the students in the learning process and makes them positively disposed to the subject matter and also help students to interact with the subject matter at the semi-concrete rather than at an abstract level. Arlidge, Thanukos and Bean (2017) also collaborates that flowchart represents a concept in science in a dynamic and non-linear process with feedback that one can take into a scientific investigation.

Gender influence on student' academic achievement in biology from the various studies cited indicated conflicting and inconclusive findings. For instance, findings of Okwo and Otubah (2007) showed that female pupils performed better than their male counterparts in basic science. The findings was supported by the findings of Etiubon (2011) that girls achieved more than boys in chemistry subject and that female learners show some superiority over male learners. However, in contrast to those research findings, Ekeh (2004) showed male superiority in cognitive achievements in biology and Oludipe (2012) also contend that male students achieve higher than their female counterparts in science. Etiubon and Udoh (2016) showed no significant influence of gender on students' academic achievement in biology when taught solubility using practical activities and manual. The findings of Etiubon and Udoh (2016) was also in agreement with the findings of Raimi (2010) who found that there was no significant gender difference in students academic achievement and retention in biology. In view of the controversial findings, the study became necessary to determine the influence of gender on biology students' academic achievement on the concept of circulatory system.

3.2 Summary of Findings

The results showed that there exists no significant gender influence between the academic achievement of male and female biology students taught circulatory system with virtual reality and those taught with flow chart. This indicated that the observed variance in students' academic achievement were due to instructional resources used and not gender.

3.3 Conclusion

Based on the findings from the study, it was concluded that gender is not a significant predictor of students' academic achievement on circulatory system when taught with virtual reality and flow chart.

3.4 Recommendations

1. The Federal, State and Local Government should procure computer facilities and distribute to all senior secondary schools to enhance the teaching of various concepts in biology such as circulatory system.
2. Parents and biology teachers should encourage both male and female students towards excellence in biology since gender is not a significant determinant of students' achievement in biology.

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