

EVALUATING THE EFFECTIVENESS OF COMPUTER BASED MULTIMEDIA LESSON DELIVERY APPROACHES ON SECONDARY SCHOOL STUDENTS RETENTION IN BIOLOGY IN FEDERAL CAPITAL TERRITORY, ABUJA

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Abstract

The study evaluated the effectiveness of Computer Based Multimedia (CBM) lesson delivery approaches on Secondary School Students Retention of Biology Concept. Three research questions and three hypotheses guided the study. Quasi-experimental research specifically Pretest-Posttest non-equivalent group design was employed. The population comprised 28,841 (male 12,647 and female 16,194) secondary school year one (SS1) Biology students in the 88 public secondary schools in FCT Abuja, Nigeria. 120(SS1) biology students (54 males and 66 females) were drawn using multistage sampling technique. Data was collected using Biology Retention Test (BRT) and stimulus instruments were lesson plans on Video Recorded Instruction (VRI) and PowerPoint presentation (PP). The instruments were validated by specialists from science education department, University of Nigeria Nsukka. The internal consistency of the instrument was determined using test-retest method and data correlated using Pearson Product Moment Correlation (PPMC) which yielded a reliability index of 0.79. Mean and standard deviation were used to answer research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 significance level. Results showed that students' taught biology using VRI had higher retention than those taught using PP. Further analysis showed that female students had higher retention scores than male in Biology. It was recommended that equal learning opportunity should be given to students regardless of gender in order to sustain the needed retention ability. Also, it was suggested that further studies should explore diverse content in SS2 biology using other CBM approaches to find its effect on other psychological variables in different subjects.

Keywords: Computer-Based Multimedia, Lesson Delivery, Biology, Retention and Gender.

Introduction

Biology as one of the science subjects taught at secondary level plays a vital role in developing students understanding of life processes and fostering scientific thinking essential for national development. According to Obialor, Ezeobi and Eze Nwabuchili (2020). Biology is a science subject which describes how living organism carry out their life activities and how they interact with their environment. Obialor (2016) opined that the study of biology is essential in a nation's scientific and technological development. A sound knowledge of Biology is needed in our everyday life; concerning the food we eat, water we drink and in many fields such as medicine, pharmacy, nursing and Agriculture. Despite its importance, numerous studies have revealed that students often exhibit poor retention in biology concepts which may have negatively impacted their overall performance in the subject. This persistent challenge has been linked to conventional teaching approaches that are largely teacher- centered, abstract and fail to stimulate students' curiosity or sustain and improve their retention ability (Ogunleye & Adepoju, 2019).

In recent years, advances in educational technology have opened new possibilities for improving teaching and learning outcomes. Studies have reported increasing importance of technology in modern education and how it can significantly enhance retention of biology concept as well as improve students' performance. It becomes imperative to explore how technology can effectively enhance students understanding and long-term retention of biology concepts.

Retention in this regard can be termed as the ability to remember task or materials learned. Retention is the ability to retain or recall information or knowledge gained after learning or the ability to memorize difficult subject. It is an important variable in learning especially in Biology where application of acquired ideas and practical skills are needed to solve problems. Ugwuanyi and Nneji (2020) maintained that the ability of the students to retain and remember what has been taught by the teacher depends heavily on the appropriateness of the lesson delivery approach. This is because man is endowed with limited capacity for memorization. The task before a teacher is how to help students improve on their abilities to assimilate information. Biology concepts cannot be learned effectively by mere memorization through rote learning. This shows that the ability to remember a thing becomes more effective when experiences are passed across to the learner through an appropriate instructional method. To support this assertion, researchers such as Okebukola, (2018), Ncharam (2018) and Achor, (2021) lamented on students' low retention in Biology which may have resulted in poor performance in the subject and suggested for the adoption of an effective lesson delivery approach in order to help

students understand and retain biology concepts. One of such lesson delivery approaches to be adopted is the Computer Based Multimedia (CBM) lesson delivery approach. This is because CBM has the capacity to transform the way the teacher teaches and the way the learners learn. This study therefore seeks to evaluate the effectiveness of Computer Based Multimedia (CBM) lesson delivery approaches on secondary school students' retention of Biology concepts.

Computer Based Multimedia (CBM) refers to the integration of various media elements such as text, graphics, audio, video, animation and interactive elements within a computer system or application. CBM as stated by (Vaughan, 2018) enables teachers to deliver instructions in more engaging and effective ways, incorporating visuals, audio and interactive exercises to reinforce concept and facilitate understanding. There are many modern CBM resources. This CBM resource includes android phones, blue-tooth speakers, computers, projectors among others. These tools can assist teaching in combination with text, graphics, power-point, video recorded instructions among others (Mayer, 2018). The application of these tools in lesson delivery may increase learning effectiveness and at the same time contribute to the attainment of UNESCO's main goals in education which is to make "Quality Education" more accessible for all (UNESCO, 2018). CBM allows information to be easily transferred from one location to another as well as aid integration of text, pictures, power-point, audio and video with links and tools that allow the user to navigate, engage, create and communicate using a computer screen.

Lesson Delivery Approach (LDA) refers to the method a teacher adopts to facilitate learning and effectively attain the pedagogical objectives. It serves as a guiding principle that shapes lesson planning, classroom interactions and assessment strategies. According to Reyes and Kleyn (2019), lesson delivery is usually the core of learning and can only be implemented in a conducive and supportive environment in which the learner gets involved in the activities. This expression of learning activities could be effectively carried out using CBM. This is because CBM lesson delivery approach according to (Onyegegbu, 2022) allows the combination of all the media elements like texts, graphics, and animation, among others to make information more brief, interesting, attractive and worthwhile. It therefore becomes imperative that Biology teachers should be able to identify what captures the minds of today's learners and choose an LDA that will be suitable for a given lesson topic (Dabbagh & Kitsantas, 2017).

There are many modes of CBM lesson delivery approaches which are virtual reality simulations, video recorded instruction, power-point presentation, audio tape instruction among others. Virtual Reality Simulation (VRS) is a CBM

lesson delivery approach which models a real life or imaginary situation in order to give the learners the ability to visualize a process. Audio Tape Instruction (ATI) is a CBM format in which instructions are delivered through spoken words, allowing the learners to listen and absorb the content without relying on written text. Video Recorded Instruction (VRI) is a form of CBM lesson delivery approach that conveys information through two simultaneous sensory channels (aural and visual). It often uses multiple presentation modes such as verbal and pictorial representation (Mayer, 2018). Power Point Presentation (PPP) is a software used to perform computer-based multimedia presentations. It is a virtual medium that allows the users to manipulate text, pictures, models and other graphical elements with great creative flexibility. These CBM lesson delivery approaches can be used to enhance teaching and learning if rightly chosen. Choosing the right lesson delivery approach especially in the delivery of science lessons such as Biology is very vital because it determines how well the students will understand the concept and recall information. However, in this study the two CBM lesson delivery approaches studied were Video Recorded Instruction (VRI) and PowerPoint Presentation (PP).

VRI is a form of CBM lesson delivery approach that conveys information through two simultaneous sensory channels (aural and visual). VRI is a motion based audio-visual model which can provide verbal and pictorial representation of information using multiple presentation modes such as verbal and pictorial representation (Mayer, 2018). Cruse (2019) stated that teachers have recognized the power of audio-visual materials in capturing the attention of learners, increasing their motivation and enhancing their learning experience.

PP is a presentation program developed by Microsoft that allows the users to create, edit and present slideshows. PP is a static visual model widely used for creating visually appealing presentations for various purposes such as business meeting, academic lectures and classroom lesson delivery. The use of PP in lesson delivery allows the users to manipulate text, pictures, models and other graphical elements with great creative flexibility. Students can observe, explore and take notes through the slide handout feature. Highlighted features can be used to focus the attention of the students during the lesson (Information Technology Services, 2016). Misubau (2019), emphasized that PP presentation can enhance the effectiveness of classroom lessons by highlighting the key points, displaying learning objectives, presenting information and direction to students.

The choice of these two approaches is because both have special features which differentiate them from other approaches and from each other and thus can be studied to determine their differential effects on students' retention of biology concept. The notable differences is that VRI portrays a continuous stream of audio

and visual content, often featuring an instructor delivering a lesson while PP presentation consist of a series of slides containing text, images and multimedia elements often accompanied by spoken narration. Again, VRI is generally less interactive as learners typically watch the video passively without the ability to interact with the content whereas PP can incorporate interactive elements such as hyperlinks, clickable buttons, quizzes and animations; allowing viewers to engage with the material to some extent.

Despite the differences between VRI and PP, both approaches can be used to enhance retention especially in Biology but the choice of the approaches depends on the nature of the content to be studied and available resources. Teachers especially Biology teachers should consider students interest as a key factor for achieving retention. This means that teachers should be intentional when choosing an LDA since the goal of teaching and learning is to achieve success (Renninger & Hidi, 2016). Based on these, the researcher evaluated the effectiveness of VRI and PP lesson delivery approaches on secondary school students' retention of Biology concept in spite of gender. This is because poor retention in Biology can be experienced by both genders.

Gender refers to the social, cultural and psychological attributes and roles associated with being male or female or non-binary. Thus, gender is a social or cultural determinant that varies from culture to culture. Gender issues have become very important among researchers. According to Nworgu (2018), there is an acknowledged problem of female poor retention when compared with their male counterparts apparently under equivalent conditions and this appears to be more pronounced in science. Biology is given feminine outlook by educational practitioners as noted by (Agommuoh & Babajide, 2020). The researchers reported that gender influences students' performance. Nevertheless, some factors have been identified to account for differences in male and female retention in Biology. Prominent among these factors is the sex stereotyping. Okeke (2019) noted that sex role stereotyping seems to be the origin of differences between male and female retention of factual information in Biology.

On the other hand, some research works has shown contradictory evidence on students' retention in relation to gender. For instance, Ifeakor (2018) found out that there is no significant difference in male and female students' retention of Biology concept. Ukwungwu (2018) posit that the extensive growth of technology uses in teaching and learning and the policy stipulating its integration into every subject taught in secondary schools will prompt both the male and female students to develop interest and improve retention of concepts. In view of these, the influence of gender on students' retention of biology concept was determined using VRI and PP

presentation in Secondary Schools in Federal Capital Territory (FCT), Abuja, Nigeria.

Purpose of the Study

Specifically, the study determined;

1. The effectiveness of VRI and PP on secondary school students' retention in Biology.
2. The influence of gender on students' retention in Biology.
3. Established the interaction effect of VRI and PP and gender on students' retention in Biology.

Research Questions

The study was guided by the following research questions.

1. What are the mean retention scores of students taught Biology using VRI and those taught using PP?
2. What is the influence of gender on students' retention in Biology?
3. What is the interaction effect of VRI and PP and gender on students' retention in Biology?

Hypotheses

The following hypotheses were tested at five percent (5%) significance level.

Ho₁: There is no significant difference in the mean retention scores of students taught Biology using VRI and those taught using PP presentations.

Ho₂: Gender has no significant influence on students' retention in Biology.

Ho₃: There is no significant difference in the interaction effect of VRI and PP presentation and gender on students' retention in Biology

Method

The study adopted a quasi-experimental research design specifically the Pretest-Posttest non- equivalent group design. Nworgu, (2018) defined quasi experimental design as an experiment where random assignment of subjects to experimental and control groups is not possible. In this case, intact classes were used. The population comprised 28,841 secondary school year one (SS1) students in the 88 public secondary schools in FCT Abuja, Nigeria. A sample of 120 SS1 biology students of the population was drawn from four different schools with functioning computer facilities through purposive sampling technique out of which four intact classes of 30 students each were selected using simple random sampling procedure. Two intact

classes were assigned to VRI and PP respectively using simple random sampling. Data was collected using Biology Achievement Test and Biology Retention Test (BRT) developed by the researcher and validated by experts from Science Education department, University of Nigeria Nsukka. The internal consistency of the instrument was established using Pearson's Product Moment Correlation (PPMC) which yielded a reliability index of 0.79. Research questions were answered using Mean and standard deviation while hypothesis were analyzed using ANCOVA tested at 0.05% significance level.

Results

Research Question One: What are the mean retention scores of secondary school students taught biology using VRI and those taught using PP?

Table 1: Mean and standard deviation of the methods on students' retention in secondary school Biology

Methods	N	Posttest		Delayed Posttest		Loss in mean
		Mean	SD	Mean	SD	
VRI	60	29.72	3.420	38.88	5.705	9.16
PP	60	21.65	3.709	23.73	4.210	2.08

NB: VRI= Video Recorded Instruction; PP= PowerPoint presentation; SD= Standard Deviation

Result in **table 1** shows that students taught biology using (VRI) had posttest mean scores of 29.72 with standard deviation of 3.420 and delayed post-test mean scores of 38.88 with a standard deviation of 5.705 while those taught using PP had posttest mean scores of 21.65 with a standard deviation of 3.709 and delayed post-test mean retention scores of 23.73 with a standard deviation of 4.210. Students taught with VRI had higher retention mean scores than those taught with PP. To confirm whether the differences in the mean retention scores of students taught biology using VRI and PP is statistically significant, the researcher tested hypothesis one at 0.05 significance level.

Hypotheses One: There is no significant difference in the mean retention scores of students taught biology using VRI and those taught using PP.

Table 2:

Analysis of covariance of the effect of VRI and PP on students' retention in Biology

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	10933.779 ^a	2	5466.889	334.041	.000	.851
Intercept	154.741	1	154.741	9.455	.003	.075
Pre-Retention	1051.104	1	1051.104	64.225	.000	.354
Methods	1695.705	1	1695.705	103.612	.000	.470
Error	1914.813	117	16.366			
Total	119473.000	120				
Corrected Total	12848.592	119				

a. R Squared = .851 (Adjusted R Squared = .848)

Analysis in **Table 2** shows the analysis of covariance of the effect of VRI and PP on students' retention scores in Biology. The result shows that an f-ratio of ($F(1, 119) = 103.612, p < .05, \eta_p^2 = .470$) was obtained. Since the associated probability value of 0.000 is less than 0.05 set as level of significance, the null hypothesis was rejected. Thus, inference drawn is that there was a significant difference in the mean retention scores of students taught biology using VRI and those taught using PP. This shows that teaching biology using VRI method proved to enhance students' retention more than PP.

Research Question Two: What is the influence of gender on students' retention in Biology?

Table 3: *Mean and standard deviation of students' retention in secondary school Biology with respect to gender*

Gender	N	Posttest		Delayed Posttest		Loss in
		Mean	SD	Mean	SD	Mean
Male	54	25.76	4.539	29.81	10.102	4.05
Female	66	25.62	6.028	32.80	10.699	7.18

NB: SD= Standard Deviation; N = Number of Respondents

Result in **Table 3** shows the mean and standard deviation of students' retention scores in secondary school biology with respect to gender. The result also indicates that male students had posttest mean scores of 25.76 with standard deviation of 4.539 and delayed post-test mean scores of 29.81 with a standard deviation of 10.102 while female counterparts had pretest mean scores of 25.62 with a standard deviation of 6.028 and delayed post-test mean scores of 32.80 with a standard deviation of 10.699. The mean loss scores of 4.05 and 7.18 respectively for male and female students indicate that female students had higher retention than their male counterparts. The delayed posttest mean scores of male and female students were greater than their respective posttest mean scores with the female students' group having a higher mean gain. To confirm whether gender has a significant influence on students' retention in biology, the researcher tested hypothesis two at 0.05 level of significance.

Hypotheses Two: Gender has no significant influence on students' retention in Biology.

Table 4: Analysis of covariance of the influence of gender on students' mean retention score in Biology

Source	Type III		Mean		F	Sig.	Partial Eta Squared (η_p^2)
	Sum of Squares	Df	Square				
Corrected Model	10977.222 ^a	4	2744.305	168.644	.000	.854	
Intercept	143.986	1	143.986	8.848	.004	.071	
Methods	1710.197	1	1710.197	105.096	.000	.477	
Gender	23.045	1	23.045	1.416	.236	.012	
Pre-Retention	1049.920	1	1049.920	64.520	.000	.359	
Methods *	20.711	1	20.711	6.273	.042	.101	
Gender							
Error	1871.370	115	16.273				
Total	119473.000	120					
Corrected Total	12848.592	119					

a. R Squared = .854 (Adjusted R Squared = .849)

Analysis in **Table 4** shows the influence of gender on students' retention in biology. The result reveals that an f-ratio of ($F(1, 119) = 1.416, p < .05, \eta_p^2 = .012$) was obtained. Since the associated probability value of 0.236 is greater than 0.05 set as level of significance, the null hypothesis was not rejected. Thus, inference drawn is that gender has no significant influence on students' retention in biology. The result further showed the effect size of ($\eta_p^2 = .012$), which indicates that gender influence on students' retention in biology is .012. Thus, this implies that 0.12 percent variance in students' retention in biology can be explained by their gender.

Research Question 3: What is the interaction effect of the VRI and PP and gender on students' retention in Biology?

Table5: Mean and standard deviation of the interaction effect of methods and gender on students' retention in Biology

LDA	Gender	N	Posttest		Delayed Posttest		Loss in
			Mean	SD	Mean	SD	Mean
VRI	Male	29	30.29	3.909	37.39	6.291	7.10
	Female	31	29.10	2.743	38.34	5.059	9.24
PP	Male	25	21.31	4.300	21.49	5.098	0.18
	Female	35	19.92	2.743	21.88	2.361	1.96

NB: SD= Standard Deviation; N = Number of Respondents; VRI= Video Recorded Instruction; PP= PowerPoint presentation

Analysis in **Table 5** shows that male students who were taught biology with VRI had a posttest mean scores of 30.29 with a standard deviation of 3.909 and delayed posttest mean scores of 37.39 with a standard deviation of 6.291. The different between the posttest and delayed posttest mean scores for the male students was 7.10. Also, the female students who were taught biology with VRI had a posttest mean scores of 29.10 with a standard deviation of 2.743 and delayed posttest mean scores of 38.34 with a standard deviation of 5.059. The different between the posttest and delayed posttest retention mean scores for the female students was 9.24. Similarly, for male and female students who were taught biology with PP, the male students had a posttest mean scores of 21.31 with a standard deviation of 4.300 and a delayed posttest mean scores of 21.49 with a standard deviation of 5.098. The

different between the posttest and delayed posttest mean scores for the male students was 0.18. Also, the female students had posttest mean scores of 19.92 with a standard deviation of 2.743 and delayed posttest mean scores of 21.88 with a standard deviation of 2.361. The different between the posttest and delayed post mean scores for the female student was 1.96. Moreover, for each of the group, the posttest mean retention scores were greater than the posttest mean scores, with the female students having a higher mean retention scores than their male counterparts in video group. Nevertheless, in PP group, the female students slightly had a higher mean retention score than the male students.

Besides, the figure below shows the retention mean plot of interaction effect of treatment and gender on students' in biology. The figure shows that the interaction effects of methods and gender on students' retention in biology is significant because the line of gender intersected at a level of the methods used. To strengthen the research question three above, the researcher tested hypothesis three at 0.05 significance level.

at 0.05 significance level.

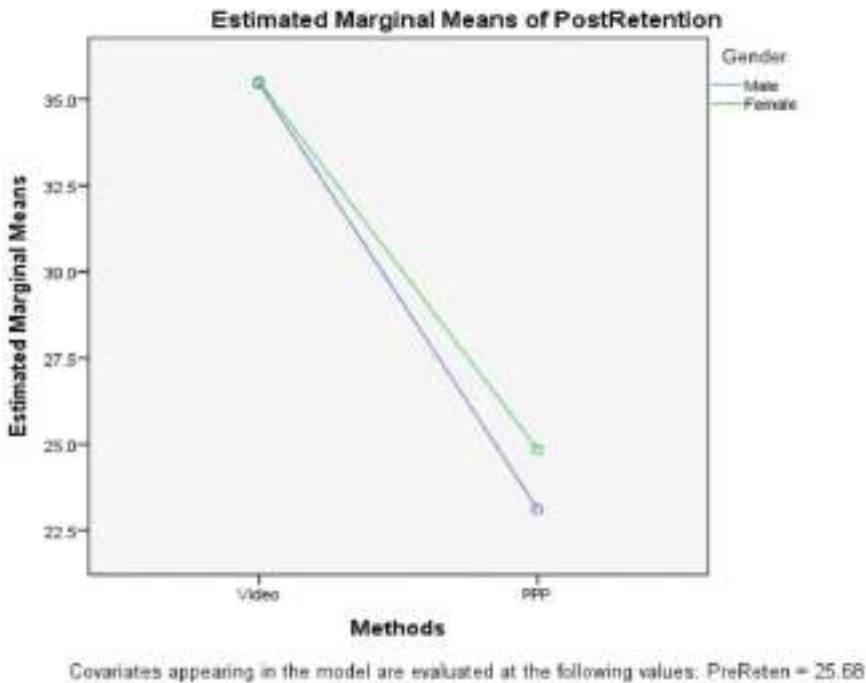


Figure 1: Retention mean plot of interaction effect of methods and gender in Biology.

Hypotheses Three: There is no significant difference in the interaction effect of VRI and PP and gender on students' retention in biology.

Analysis in **Table 5** shows the analysis of covariance of the interaction effect of VRI and PP on students' retention scores in Biology based on their gender. The result shows that an f-ratio of ($F(1, 119) = 6.273, p < .05, \eta_p^2 = .101$) was obtained. Since the associated probability value of 0.042 is less than 0.05 set as level of significance, the null hypothesis was rejected. Thus, inference drawn is that there was a significant difference in the interaction effect of VRI and PPP and gender on students' retention in biology. The result further showed the effect size of ($\eta_p^2 = .101$), which indicates that the effect VRI and PP approaches had on students' retention in biology based on their gender is 10.1. Thus, this implies that 10.1 percent variance in male and female students' retention in biology can be explained by the LDA used.

Discussion

The finding of the study shows that students' taught Biology using VRI had higher retention mean score than their PP counterparts. This means that students who learned Biology through VRI showed enhanced retention in the subject compared to students who were taught using PP approach. This could be due to the fact that VRI can often combine visual, auditory and sometimes textual elements, catering to different learning styles. The above findings are in-line with the finding of Ugwuanyi, Nwankwo and Ugwuoke (2016). The researchers revealed that PP presentation enhanced students' retention than using demonstration method. Also, the study showed that there was a significant difference between male and female students' retention in physics. On the contrary, Ikeh, and Orji (2016) study is not in agreement with the finding of the present study since it revealed that there is no significant difference in the mean retention score of students in Physics.

The findings of the study show that female students had higher retention than male in Biology. This means that gender influence on retention in learning Biology is in favour of female student. This could be because most male students prefer calculations like balancing of equation and theories among others which are not encapsulated in Biology as a subject. Finding of the study here agrees with that of Obiekwe (2018), Musibau and Johnson (2019) which showed that the majority of the female students in Bindura urban, (80%) had good retention level in biology than the male. On the contrary, the finding of the study here is not in line with that of Okereke (2019), Ntibi and Edoho (2017). Okereke, 'Ntibi and Edoho's studies revealed that gender had no significant influence on students' retention in Biology.

The finding of the study showed that the posttest mean retention scores were

greater than the pretest mean scores with the female students having a greater mean retention scores than the male in both groups (VRI and PP). This means that after intervention, female students had a higher retention in Biology than the male compared to their retention before the intervention. This means that the combined effects of VRI and PP and students' gender have a notable impact on retention in Biology. Finding of the study here agreed with that of Cleopas and Igbojinwaekwu (2023). Cleopas and Igbojinwaekwu's research revealed that gender and treatment has interaction effect on students' retention. However, Okeke (2020) disagrees with the study since it unveiled that there was no significant interaction effect of treatment and gender on students' retention. The differences in the findings of the reviewed studies and the present study could be attributed to both studies not focussing on the use of VRI and PP as teaching approach for Biology specifically in FCT, Abuja.

Conclusion

From the finding of the study, it was conclude that VRI was paramount in sustaining what the students learnt over a period of time (retention) more than PP. It was also conclude that both VRI and PP was effective in improving the retention of female students more than their male counterpart. It is therefore pertinent to say that both VRI and PP are significant method of teaching biology in senior secondary school.

Recommendations

In view of the finding, the researchers recommend that:

1. Biology teachers should adopt the VRI lesson delivery approach since it had a significant improvement on students' retention of biology concept.
2. Curriculum planners should enshrine the use of VRI lesson delivery approach into the content of instructional program and ensure its implementation.

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