

## COMPARATIVE EFFECTS OF MULTIMEDIA INSTRUCTIONAL MODES ON STUDENTS' INTEREST AND ACHIEVEMENT IN BIOLOGY

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### Abstract

The study compared the effects of two multimedia instructional modes on students' interest and achievement in biology. Two research questions and two null hypotheses guided the study. The study employed quasi-experimental research design. The population of the study consisted of 191 first year students (43 males, 148 females) of Biology Education in five federal universities in South-East Nigeria. The sample consisted of 127 first year students (31 males, 96 females) from two federal universities in the population of study. Intact classes were used for the study. Two research questions and two hypotheses guided the study. The treatment and test instruments were a Multimedia Instructional Package (MIP), Biology Achievement Test (BAT) and Biology Interest Scale (BIS). The instruments were validated and trial tested. Reliability coefficient of 0.8 and 0.70 were established for BAT and BIS using Kuder Richardson (KR-20) formula and Cronbach alpha method respectively. Research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The result revealed that MIP had significant positive effect on students' interest and achievement in biology. However, students taught with animation with text mode had statistically higher interest and achievement mean score than those taught with animation with narration mode. Based on the findings, it was recommended that the animation with text mode be adopted by lecturers in teaching abstract and complex processes in biology. The researchers also recommended that further research work be carried out on the effectiveness of animation + text mode on undergraduate students' interest and achievement in other complex science processes.

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**Keywords:** Multimedia Instructional Modes, Interest, Achievement, Biology.

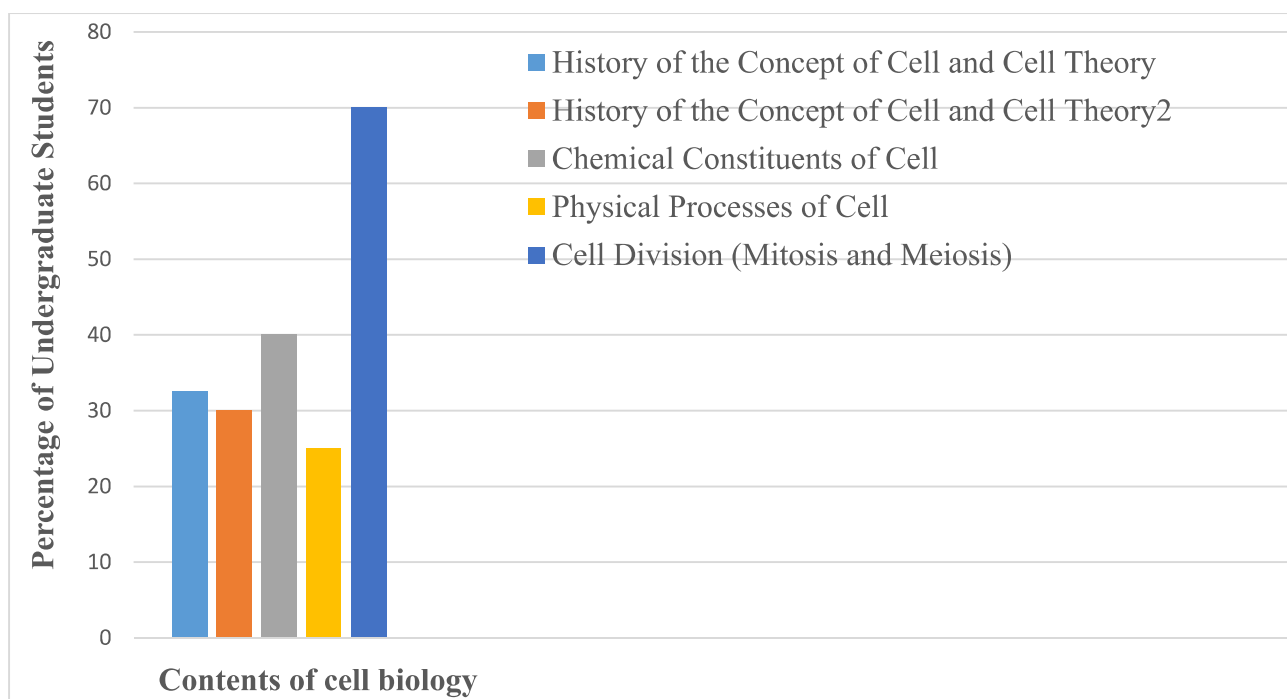
### Introduction

Biology is the study of living things. It is a basic subject of modern life sciences that deals with the study of plants and animals. The study of biology covers the processes that take place in both plant and animal cells and extends to the study of the biosphere, ecosystem and global climate change. Biology is a subject in senior secondary schools. It is also a basic course for undergraduate students of science education in Nigeria (National Commission for Colleges of Education (NCCE), 2012). According to Federal Republic of Nigeria (FRN) (2014), the learning of biology will provide students with suitable laboratory and field skills in biology. It will enable them to acquire meaningful and relevant scientific knowledge which is applicable in health, agriculture and personal life matters. It will also enable the development of functional scientific attitudes in students. From the above statements, the overall aim of biology education in Nigeria is to equip students with a solid foundation in biological sciences and prepare them for future academic and professional pursuits in the field of biology.

The learning of biology is therefore important for the obvious reasons. It provides students with a wealth of knowledge on the molecular and scientific basis of life. In support of this, Ndirika and Anidu (2020) stated that the study of biology is essential for scientific literacy and understanding of life processes. Also, the study of biology enables students to gain meaningful understanding of the cellular basis for healthy growth and diseased conditions. Lukow (2021) asserts that many cellular diseases of global concern are basically as a result of uncontrolled or unchecked biological processes in the body, example, cancer disease. So, in order to fight the menace of cancer and other deadly diseases, a deep and intense study into some biological processes is required. Research and studies in biology have also enhanced diagnoses, treatments, and cures of diseases (Lukow (2021). It has also enabled biologists working in animal, plant and medical sciences to be able to develop new vaccines, more effective medicines, and plants species with improved qualities.

However, despite the importance of learning biology, many students tend to lack interest in learning the subject. Interest is an important variable in the teaching and learning process. It can be defined as a display of positive attitude towards an object or situation. According to Chikendu (2018), interest refers to a person's enjoyment of an activity or situation. So, interest in biology can be viewed as a positive disposition or likening for the learning of biology. Several studies have reported poor students interest in biology over the years (Abdulrahman, Yusuf, Arinde, Muhammad-Thani, 2022; Okoro & Oluwasegun, 2020; Etobru, 2017). A lot of factors have also been attributed to this. Some of these factors include: use of poor teaching strategies and methods that make learning less engaging and uninteresting (Raiyegbemi, Osokoya, Taiwo, Adu, Nsofor, Adeniran & Ajani, 2020); use of traditional media in teaching dynamic biological processes (Gambari, Yaki, Gana & Ughovwa, 2014); curriculum limitations, social influences, peer attitudes and students perception of some complex processes in biology as abstract and difficulty to learn (Odunukwe, 2024). A survey study by the researchers revealed that undergraduate students perceive some aspects of biology to be abstract and difficult to understand. This negative perception on some complex biological processes has contributed to their lack of interest in learning biology. Figure 1. below is a bar chart showing percentage of students perceiving some biology contents as abstract, complex and uninteresting to learn.

**Figure 1. Percentage of students perceiving some biology contents as abstract, complex and uninteresting.**



Source: (Odunukwe, 2024).

As the bar chart indicates, the percentage of students perceiving cell division as abstract, complex and uninteresting is 70%. This is highly disturbing, considering the fact that cell division is an important, if not the most important topic in biology. It enables students to gain knowledge of the cellular basis of reproduction, growth and development. Effort should therefore be intensified towards addressing the challenge of students' poor interest in biology, especially cell division. This is because interest has been noted to significantly impact on achievement in any subject. Kusmaryati and Amertaningrum (2017) noted that interest serves as a motivational factor in learning which tend to drive achievement. So, when students' interest in biology is enhanced, they are more likely to become actively engaged in the learning process and ultimately perform well in class. Interest, therefore forecasts measures of educational success, including future course taking and achievement.

Achievement is an important learning outcome in education. Achievement can be defined as students' performance outcomes after completing a definite or particular task. Herrera, Al-Lal and Mohamed (2020) defined achievement as the final grades of students in school subjects. Achievement in biology can therefore be stated as the extent to which a student attained educational goals in biology when measured, tested or assessed on a pre-determined scale. There are several reports of student' poor achievement in biology, especially cell division. The worrisome situation was observed in both secondary and tertiary institutions (Raiyegbemi, Osokoya, Taiwo, Adu, Nsofor, Adeniran & Ajani, 2020; Ali, Toriman & Gasim, 2014; Lebata & Mudau, 2014). A number of reasons were also attributed to that. Some researchers argue that biological processes are naturally abstract and complex in nature making it difficult for most student to understand and perform well in biology (Chukwuemeka & Dorgu, 2019). Other studies attributed the poor achievement to factors such as poor teaching methods (Mamalanga, & Awelani, 2014), non-use and unavailability of modern instructional facilities and resources (Daworiye, 2015) and, poor teacher competency and motivation (Agboghoroma & Oyovwi, 2015). Other possible factors may include students' background and physiological variables.

The picture today is that biology education is failing. The results of undergraduate students in cell biology in a tertiary institution in Nigeria as shown in Table 1 are highly disturbing, considering the fact that the students would become future scientists and teachers in secondary schools after their graduation.

**Table 1: Results of undergraduate biology students in (Cell-Biology) 2013 – 2018**

<b>Session / Year</b>	<b>No. of candidate that sat for the exam</b>	<b>Passed at credit level (A–C) %</b>	<b>Passed (D–E) %</b>	<b>Failed (F) %</b>
2013	850	201(23.65)	184(21.65)	465(54.47)
2014	544	111(20.40)	104(19.12)	329(60.48)
2015	343	98(28.57)	96(27.99)	149(43.44)
2016	322	75(23.29)	134(41.61)	113(35.09)
2018	216	32(14.81)	63(29.17)	121(56.02)
2019	168	21(12.5)	24(14.29)	123(73.21)

Source: Exam and Records, Kwara State College of Education (Technical), Lafiagi.

(Adopted from Abdulrahman, Yusuf, Arinde & Muhammad-Thani, 2022).

As Table 1 indicates, the number of students that passed biology at credit level (A-C) was consistently less than 30% for the years (2013-2019) in the tertiary institution used as case study. From research evidence, educators see the pressing need to reconsider the techniques, methods and media of instruction at tertiary institutions. To address these challenges, there is need for an instructional system that is supported by the use of interactive learning environments and innovative multimedia tools. Multimedia instruction tools such as computers may have significant impact on students interest and achievement. This is because a well-designed instruction using multimedia instructional tools foster motivation, curiosity, and engagement, while a poorly designed one can diminish enthusiasm and hinder achievement (Daworiye, 2015). In other words, a learning environment with innovative multimedia tools can build students' intrinsic motivation and interest, and helps them achieve higher levels of academic success. However, for deep and meaningful learning of biology, especially cell division, effective or appropriate multimedia learning modes should be employed in the instructional design.

Multimedia instructional modes denotes various ways, formats or approaches by which multimedia instructions are presented to learners. It comprises of different formats or presentations of words and pictures in a multimedia learning environment

(Mayer, 2017). Words can be presented in multimedia learning as written text or spoken text (audio/narration) while pictures might be presented as illustrations, photos, graphics, video or animation. Animation is a basic feature in multimedia learning (Liu, 2019). Consequently, multimedia instructional modes consist of different combinations of animation with text or with audio such as; animation with text (AT) and animation with narration (AN). Such combinations are different modes through which new information is conveyed and taught. It is therefore, expedient that multimedia presentation designers take into cognizance the different multimedia instructional modes and how to use them in education to assist cognition. There are three different modes of multimedia presentations or modes and they all have root on Mayer's modality and redundancy principles of multimedia learning.

According to the modality principle, the multimedia mode of animation + narration (AN) is more effective for learning than that of animation + text (AT) (Castro-Alonso & Sweller, 2021). According to the redundancy principle, the multimedia mode of animation with narration (AN) is more effective for learning than that of animation with narration and with text (ANT)(Mayer, 2017). However, empirical studies and evidences on the effect of modality principle on students learning is inconclusive.

For example, studies by Gambari, Ezenwa and Anyanwu (2014) on the effect of two modes of computer-assisted instructional package on mathematics learning, revealed that students taught using animation with narration (AN) mode had more effective learning than those taught using animation with text (AT) mode. This concurs with the study of Yadav, Phillips, Lundeberg, Koehler, Hilden, and Dirken (2011) which examined the differences in affective and cognitive processing of video and text cases. The result revealed that students who viewed the animation with narration (AN) mode had better recall of details than those that viewed with animation with text (AT) mode. Again, AN mode was more powerful than AT mode in the affective realm. Other studies such as the one by Oberfoell and Correia (2016) and, AbuSaad, Lee and Fong (2013) validated the above claims. They attested to the fact that students who received instruction using the AN mode had more effective learning than those taught with AT mode.

However, other studies presented contrarily reports. They reported no significant difference in the effectiveness of different multimedia learning modes on learning and knowledge transfer scores of students. Example, the study by Liu (2019) to ascertain the optimum input mode for ESL (English as a Second Language) undergraduate students' learning. Findings from the study revealed no significant difference in the learning and knowledge transfer scores of students taught with the AN and AT modes. None of the groups had more effective learning than the other. This concurs with the findings of Pastore, Asino and Briskin (2019) who examined the effects of multimedia redundancy and modality principles in a computer-based environment on recall, transfer, and cognitive load with adult learners in biology. They reported that learners who received instruction with AN mode performed just as well as those with AT mode.

So, empirical evidences on effectiveness of different multimedia learning modes on students learning are conflicting. The conflicting evidences in the effectiveness of different multimedia learning modes informed the need to verify the assertions, by undertaking this study which examined the effectiveness of different multimedia learning modes on undergraduate students' interest and achievement in biology.

## **Statement of the Problem**

The study of biology is very important for survival of life on earth. However, the learning of biology has been a challenge to students in Nigeria. Evidence have shown that undergraduate students' interest and achievement in biology appears unsatisfactory over the years. Previous studies attributed the worrisome situation to factors such as: the use of traditional techniques and instructional media to teach biology. Hence, the need to employ innovative multimedia learning modes in the teaching and learning of biology in Nigeria. However, there are conflicting evidences on the effectiveness of different multimedia learning modes on undergraduate students' interest and achievement in biology. The conflicting evidences informed the need for this study which examined the effectiveness of different multimedia learning modes on undergraduate students' interest and achievement in biology.

## **Purpose of the Study**

The purpose of this study was to examine the effects of multimedia learning modes on undergraduate students' interest and achievement in biology.

Specifically, the study aimed to examine the:

- effect of multimedia learning modes, animation + narration (AN) and animation + text (AT) on students' interest in biology.
- effect of multimedia learning modes, animation + narration (AN) and animation + text (AT) on students' achievement in biology.

## **Research Questions**

1. What is the effect of multimedia learning modes (animation with narration and animation with text) on students' interest in biology?
2. What is the effect of multimedia learning modes (animation + narration and animation with text) on students' achievement in biology?

## **Hypotheses**

This study investigated the following hypotheses, which were tested at a significance level of 0.05.

H<sub>01</sub>: There is no significant difference in the mean interest scores of students taught biology using animation with narration (AN) and animation with text (AT).

H<sub>02</sub>: There is no significant difference in the mean achievement scores of students taught biology using animation with narration (AN) and animation with text (AT).

## **METHODOLOGY**

The research design was quasi-experimental research design, specifically pretest, post-test design. The population of the study consisted of 191 first year undergraduate students (43 males, 148 females) of Biology Education in the five federal universities in South-East Nigeria.. The sample consisted of 127 first year students (31 males, 96 females) of biology education drawn from two federal universities in the population of study. Two federal universities offering degree programme in education were randomly sampled for the study. The treatment instrument was a multimedia instructional package. Instruments used for data collection were Biology Achievement Test (BAT) and Biology Interest Scale (BIS). The instruments were validated by experts and trial tested on students with homologous characteristics with the sample. Reliability coefficient of 0.8 and 0.70 was established for BAT and BIS respectively using Kuder Richardson (KR-20) formula and Cronbach alpha method. Research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance.

## **RESULTS**

**Research Question 1:** What is the effect of multimedia learning modes (animation + narration and animation + text) on students' interest in biology?

**Table 1 :** Mean Interest Rating Scores and Standard Deviation of Students taught Biology using Animation + Narration (AN) and Animation + Text (AT) Multimedia Learning Modes.

Media	N	Pretest Interest		Post-Test Interest		Adjusted Mean
		Mean	SD	Mean	SD	Mean
Animation + Narration	70	52.07	3.44	52.51	3.85	52.51
Animation + Text	57	51.09	3.95	55.53	5.79	55.47

Table 1 revealed that students taught with animation + narration had pretest interest mean score and standard deviation of 52.07, 3.44; post-test interest mean score and standard deviation of 52.51, 3.85, and adjusted mean of 52.51. Those taught with animation + text had pretest interest mean score and standard deviation of 51.09, 3.95; post-test interest mean score and standard deviation of 55.53, 5.79, and adjusted mean of 55.47. This shows that students taught biology using animation + text had higher interest than those taught with animation + narration mode.

**Research Question 2 :** What is the effect of the multimedia learning modes (animation + narration and animation + text) on students' achievement in biology?

**Table 2 :** Mean Achievement Scores and Standard Deviation of Students taught Biology using Animation + Narration (AN) and Animation + Text (AT) Multimedia Learning Modes.

MEDIA	N	Pretest Achievement		Post-Test Achievement		Adjusted Mean
		Mean	SD	Mean	SD	Mean
Animation + Narration	70	37.43	11.64	44.61	12.17	46.85
Animation + Text	57	49.05	13.99	50.91	16.77	48.50

Table 2 revealed that students taught with animation + narration had pretest achievement mean score and standard deviation of 37.43, 11.64; post-test achievement mean score and standard deviation of 44.61, 12.17, and adjusted mean of 46.85. Those taught with animation + text had pretest achievement mean score and standard deviation of 49.05, 13.99; post-test achievement mean score and standard deviation of 50.91, 16.77, and adjusted mean of 48.50. This shows that students taught with animation + text performed better than those taught with animation + narration in cell biology.

### Research hypotheses

**H<sub>01</sub>:** There is no significant difference in the mean interest scores of students taught biology using animation with narration (AN) and animation with text (AT).

**Table 3:** Analysis of Covariance of Students' Biology Interest Scores by Media

Sources of Variation	Sum of Squares	Df	Mean Square	f	Sig	Partial Eta Squared
Covariates Pretest Interest	169.683	1	169.683	8.170	.005	
Main Effects (Combined)	1426.670	3	475.557	22.899	.000	
Media	1280.632	2	640.316	30.832	.000	.251
Model	1772.348	6	295.391	14.224	.000	
Residual	3426.692	16	20.768			
Total	5199.041	17	30.404			

a. Post-test Interest with Pretest Interest      b. Covariates entered first

Result in Table 3 revealed a statistically significant main effect for media  $F(1,165) = 30.832$ ,  $p = .000$ , partial  $\eta^2 = .251$ . Since  $p(0.000)$  is less than 0.05. The null hypothesis was rejected, indicating that there was a significant difference in the mean interest rating scores of students taught cell biology using animation with narration (AN) and animation with text (AT). The effect size, calculated using partial eta squared, was .251. This means that 25% of the variation in the dependent variable is influenced by the independent variable. To determine the direction of the differences, a Scheffe analysis was presented in Table 4.

**Table 4 : Scheffe Analysis for Pairwise Comparison of the Means Due to Media**

Media	N	Subset		
		1	2	3
Animation + Narration	70	52.51		
Animation + Text	57		55.53	
Sig.		1.000	1.000	1.000

Result in Table 4 showed that students taught with animation with text had significantly higher interest than those taught with animation with narration. This was evident in their mean interest scores of 55.53 and 52.51 respectively.

**H<sub>02</sub>:** There is no significant difference in the mean achievement scores of students taught biology using animation with narration (AN) and animation with text (AT).

**Table 5 : Analysis of Covariance of Students' Biology Achievement Scores by Media**

SOURCES OF VARIATION	Sum of Squares	df	Mean Square	f	Sig	PARTIAL ETA SQUARED
Covariates Pretest Interest	7556.893	1	7556.893	53.965	.000	
Main Effects (Combined)	14940.450	3	4980.150	35.564	.000	
Media	14484.532	2	7242.266	51.719	.000	.261
Model	23381.406	6	3896.901	27.829	.000	
Residual	23105.309	165	140.032			
Total	46486.715	171	271.852			

a. Posttest by Media with Pretest

b. Covariates entered first

Posttest by Media with Pretest

b. Covariates entered first

Result in Table 5 revealed a statistically significant main effect for media  $F(1,165) = 51.719$ ,  $p = .000$ , partial  $\eta^2 = .261$ . Since  $P(0.000)$  is less than 0.05. The null hypothesis was rejected, indicating that there was a significant difference in the mean achievement scores of students taught cell biology using animation with narration (AN) and animation with text (AT). The effect size, calculated using partial eta squared, was .261. This means that 26% of the variation in the dependent variable is influenced by the independent variable. To determine the direction of the differences, a Scheffe analysis was presented in Table 13 below.

**Table 6 : Scheffe Analysis for Pairwise Comparison of the Means Due to Media**

Media	N	Subset		
		1	2	3
Animation + Narration	70	44.61		
Animation + Text	57		50.91	
Sig.		1.000	1.000	1.000



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Result in Table 6 showed that students taught with animation and text (AT) performed significantly better than those taught with animation with narration (AN). The actual difference in mean scores between the groups was substantial.

## **Discussion.**

Findings from the study revealed that students taught biology with AT mode had higher mean interest scores than those taught with AN mode. And the difference was statistically significant. This can be attributed to the potential role of on-screen text in capturing students' attention. It was possible that the on-screen text in the AT mode served as a technique which captured and maintain students' attention. Toh, Munassar and Yahaya, (2010) reported that attention is the first and single most important factor in arousing learners' interest. It is a key to gain and maintain learners' interest. Thus, it was possible that learners in the AN mode failed to pay attention, which subsequently weakened their interest towards the instructional mode. However, the study by Aldalalah and Fong (2010) presented a contrary report. The researchers observed that there was no significant difference in the interest level of students with respect to the two modes (AN and AT) of the courseware used in instruction of a music theory lesson. They concluded that media had no effect on students interest in learning.

The study also revealed that students taught with AT mode achieved better than AN mode. And the difference was statistically significant, implying that the actual difference in mean scores between the groups was substantial. This shows that the modality effect is no longer impacting learners as it was about twenty years ago. The rationale behind this change can be attributed to high experience level of the participants, not with content of the study but instead, with technology, online learning, and multimedia formats that include animation and text. Thus, the processing of information from both animation and text in the visual channel failed to constitute extraneous cognitive load but rather aided cognition. The synchronized on-screen text did not impede learning; rather it reduced the cognitive load and enhanced learning and achievement of students in cell biology. This agrees with the study of Oberfoell and Correia (2016) who reported that animation with onscreen text was more effective for low-experienced learners than the narrated version. However, the findings are not in consonance with that of AbuSaada, Lee and Fong (2013) and Gambari, Ezenwa and Anyanwu (2014) who found that achievement of students in solid geometry with AN courseware mode was better than their colleagues who in AT mode. They validates the findings of Richard Mayer's (2001) multimedia modality principle and also confirmed the findings of Adegoke (2010) that multimedia based instruction involving animation with narration results in a more significant learning outcome than animation with onscreen text.

## **Conclusion**

The study revealed that learning with different multimedia modes enhanced undergraduate students interest and achievement in biology. Students taught with AT mode had significantly higher interest and achievement than those taught with AN mode. This indicates that AT mode is more effective in enhancing undergraduate students' interest and achievement in biology. Based on these findings, the researchers advised that the AT mode be used in teaching and learning of biology at all levels of

education. It can serve as a medium of improving undergraduate students' low interest and poor achievement in biology.

### **Recommendation**

Further research work should be carried out on the effectiveness of animation with text mode on undergraduate students' interest and achievement in other complex science processes.

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