EFFECT OF DNA ANIMATION, IMPROVISED MODEL AND REALIA ON TEACHING AND STUDENTS' PERFORMANCE BASED ON SCHOOL LOCATION IN BIOLOGY IN AKWA IBOM STATE, NIGERIA

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Abstract

The study determined the effect of DNA animation, improvised model and realia in enhancing students' performance based on school location when used to teach the concept of DNA in Biology in secondary schools in Akwa Ibom State. To achieve the purpose of the study, three research questions and three hypotheses were formulated to guide the study. The quasi experimental research design was adopted and the study was carried out in the three senatorial districts (Uyo, Ikot Ekpene and Eket) in Akwa Ibom State. Population of the study consisted of all the 51,843 students with males accounting for 22,260 and females 29,583 of Senior Secondary Two (SS2) students. A sample size of 879 senior secondary II students drawn from 18 schools in their intact classes through multi stage sampling technique was used for the study. DNA unit test (DNAUT) was used as instrument for data collection. The instrument was duly validated and subjected to reliability analysis using Kuder Richardson 20 (K-R20). The result showed a reliability coefficient of 0.83 and was deemed appropriate for the main study. Descriptive statistics of mean and standard deviation were used in answering the research questions while analysis of covariance was used in testing the hypotheses at 0.05 alpha level. From the results of the analyses carried out, the findings showed that there was a significant difference in students' academic performance when taught using animation, improvised model and realia in the concept of DNA based on school location than their control group counterparts in Biology. From the findings, it was concluded that students taught with realia instructional material had better academic performance followed by animation and improvised model on the part of the students based on school location.

Keywords: DNA Animation, Improvised Model, Realia, School Location, Academic Performance and Biology.

Introduction

Education is the systematic development or training of the mind, capabilities or character through instruction. In Nigeria, education is considered an instrument par excellence for national development (FRN, 2014), thus, it is fundamental in achieving a more rapid economic, social, cultural, technological as well as scientific development. Hence, Aniodo and Eze (2014) defined science as a rationally structured knowledge about nature, which embraces systematic approaches of positive attitudes for its acquisition, teaching, learning and application. Science is receiving much emphasis in education. Science education is the field concerned with searching for scientific knowledge and expanding the frontiers. Okebukola (2020) opined that no nation can develop without science education. The Federal Republic of Nigeria (FRN, 2014) in her

National Policy on Education stated that the goals of science education in Nigeria shall be to produce scientists for national development; and to provide knowledge and understanding of the complexity of the physical world. Science subjects taught in secondary schools in Nigeria include mathematics, chemistry, Biology and Physics.

Biology as one of the science subjects is concerned with the study of living things including their functioning, structure, growth, evolution, distribution, identification and taxonomy. It is central to many science related courses including medicine, Biochemistry, Pharmacy, Nursing science and Agriculture. Being a science of life, Biology is one of the core science subjects taught in the senior secondary schools. Hence, it occupies a very important position in the secondary school curriculum.

In Nigeria, the secondary school Biology curriculum is designed and developed to prepare students to acquire adequate laboratory and field skills, meaningful and relevant knowledge in Biology and also to enable students apply scientific knowledge to everyday life in matters of personal, community, health and agriculture among others (FRN, 2014). Biology is introduced to students at the senior secondary school level as a preparatory ground for human development, where career abilities are groomed, potentials and talents are discovered and energized. Today, Biology pervades literally every field of human endeavors and plays a fundamental role in educational advancement (Aninweze, 2014).

There are different concepts in Biology, among which; is genetics. The concept of Genetics is very important for human growth, development, food science, plant and animal breeding. Genetics according to Ramalinagam (2013) is the study of genes, genetic variation and heredity in living organism. DNA – Deoxyribonucleic Acid is a concept in genetics. Students constantly struggle with the topic DNA as it is such intangible concept that students have a hard time grasping (Ogunbanwo, 2019). The genetic material inside cells responsible for the development and function of an organism is called DNA. DNA molecules generate information and passed it from one generation to the next. DNA is the information molecule. It stores instructions for making other large molecules, called proteins. These instructions are stored inside each cell, distributed among forty-six long structures called chromosomes. These chromosomes are made up of thousands of shorter segments of DNA, called genes (Nya *et al*, 2019).

Principally, the modern working definition of a gene is a portion or sequence of DNA that codes for amino acids which is known to be responsible for cellular functions or processes. Therefore genetics could also be defined as a branch of Biology concerned with the study of heredity and variation in organisms. Alternatively, it can also be defined as the study of inheritance or patterns of inheritance from parents to offspring, naturally or artificially from generation to generation. It is apparent from the above definitions that Genetics is broad-based rather than narrow, with practical and scientific learning in science education and applied sciences. It is indeed an all-embracing field within whose ambit are the following areas of studies; cytogenetic, molecular genetics, microbial genetics, radiation genetics, human/clinical genetics, biometrical genetics, quantitative genetics and genetic engineering or biotechnology (Nya *et al*, 2019).

The term instructional materials is used to denote resource materials, devices or anything which can help to transmit learning experiences through any of the senses of touch, sight, smell, taste and hearing (Moses, 2020). The use of appropriate instructional materials in teaching Genetics could help to assuage this poor performance. Instructional materials are those materials used in the classroom and science laboratory for instructions and purposes of demonstration by teachers and students. Conversely, teachers neglect from teaching this topic because of its complexity; students find it difficult because they perceive it as being difficult, abstract and boring hence; students may perform poorly in examinations (NERDC, 2015). They are used by teachers in classroom to aid in the attainment of specific learning objectives set out in classroom plans (Etop, *et al*, 2023). Studies have shown that the use of instructional materials has

improved performance (Eno, *et al*, 2023). The teaching of Biology without instructional materials may certainly result in poor academic performance. According to Osinubi and Okebukola (2014), inadequate use of instructional material has constituted a problem to students' performance in Biology in the senior school certificate examination. The teaching of Biology cannot be done effectively without interaction between the teacher, students and the environmental resources. The Biology curriculum is planned and designed to enable the teacher use activity oriented, student-centered approach to teach (Oluwaseun, *et al*, 2018). However, evidence from research has shown that most teachers in Nigeria use verbal exposition of scientific principles, facts and concepts thus, performance of Nigerian students in ordinary level Biology is persistently poor over the years (Adam, *et al*, 2023). This has been a major source of concern for researchers, the school administrators, parents and the government at large. Utilization and application of instructional materials has proven over time to improve students' performance. Such materials are computer animated instructional materials, improvised instructional materials, realia (real-life laboratory activities involving DNA extractions from banana) using laboratory equipments and simple chemicals among others.

Computer animated instructional materials have also proven to be effective in the teaching and learning process. Duru *et al.,* (2024) revealed that learning could be accelerated through the use of animation and helped to concretize students' knowledge of the concept of DNA concept perceived difficult or abstract to students. The animation provided a mental scaffold which is to accelerate learning (Duru *et al*., 2024). According to Salihu, and Umar (2018), the use of computers in teaching and learning process that enable students to observe the dynamics, either as a whole or step by step, and participate in interactive activities is regarded as computer animated instruction an aspect of computer assisted instruction (CAI) founded in information and communication technologies (ICT). CAI heavily relies upon the use of ICT components to strengthen the learning processes (Itighise & Wordu, 2016). ICT components and digital and technological breakthrough(s) of the 21st century have become an integral part of our educational system and influences the education system at different levels and each stage of education by enhancing the efficiency of the teaching–learning process, making students more attentive, confident and providing each student with an individualized learning environment to learn at one's pace (Uko & Uko, 2020).

Improvised instructional model or materials as an insight into improvisation generally, is important. According to Ayua (2021), improvised instructional materials involve the act of producing and using alternative resources aimed at facilitating instruction. DNA improvised model is a manipulative model which allows student to ultimately translate a DNA code-message by synthesizing a 'protein' (amino acid sequence) in readable English (Duru *et al.*, 2024). It encourages students to create and decipher new messages written in DNA language. Ezechi (2019) stated that improvised materials involve selecting and deployment of relevant instructional elements of the teaching and learning process in the absence or shortage of standard teaching and learning materials for meaningful realization of specified educational goals and objectives. Okori *et al* (2017) and Adie *et al* (2020) noted that the approach of using improvised materials in science classroom assist in proper introduction of new skills; develop understanding as well as showing the appropriate ways of doing things. Akpan (2018); Akpan and Babayemi (2022) maintained that if effective knowledge transfer is to be achieved through science teaching in this era where entrepreneurial education is greatly emphasized, there should hardly be a separation between the community and the school. It was on this ground that Inyang, *et al*, (2022) observed that the application of improvised instructional materials takes adequate care of the three domains of learning (cognitive, effective and psychomotor) thereby reducing the abstractedness of the scientific concepts.

Realia is a simple real-life laboratory activity in which DNA is extracted from organisms (plant or animal) using simple chemicals. DNA extraction provides a hand on introduction to DNA and enables students to gain real experience and practical knowledge of DNA. It allows

students to relate an abstract idea to a tangible product thus gaining a better understanding of DNA. The aim of using this technique is to promote an interest in science and a deeper knowledge of Genetics (Duru, *et al.,* 2024).

Moreso, the poor performance of students in Biology could be attributed to factors such as poor instructional delivery, large class size, insufficient laboratory facilities and inadequate time allocation (Utibe & Agwagah, 2015; Oladejo & Ebisin, 2021). Udo and Uko (2014)) asserted that, Biology remains one of the basic sciences whose teaching and learning ought to be efficient and successful, if only undertaken simultaneously with the help of adequate instructional resources and facilities. Ezechi (2019) reported that, there were inadequate resources for the teaching of Biology subject in Nigerian secondary schools. Many practical classes are not well planned and carried out due to the absence or inadequate teaching facilities such as laboratory equipments, reagents, as well as apparatus, among others (Utibe & Onwiodukit, 2019). Nkoyo (2022) reported that planning of instructional materials before lesson delivery have influence on students' quality assurance thereby helping the teacher achieving the goals of the lesson.

However, variable such as location may influence how students learn and their academic performance. Thus, it is important to consider these intervening variable in research in science education. The location of a school determines to a large extent the level of student's performance. Ellah and Ita (2017) opined that school location implies urban-rural setting. Urban schools are those schools in the municipalities or schools found within the towns and rural schools are those located in the villages or semi-urban areas. Biology, just like any other science subject is influenced by the area in which the school is cited. This affects both the teachers and the learners alike. For instance, a school located in a serene environment such as the Government Reserved Area (GRA) and the ones beside motor parts, noisy environment and commercial nerve centers and border towns cannot be compared in terms of suitability of learning. Hence, the location of a school may determine the academic performance of students. Abamba (2021) viewed school location as one of a major factor that influences students' academic achievement in science subject areas. Abamba opined that parents look at such factors as the location of schools (Urban or rural) and the distance to the school before enrolling their wards. Distance of school from home, noisy environment and other variable could be capable of hampering effective teaching and learning. Nnenna and Adukwu (2018) have reported significant differences in performance between rural and urban located schools in their studies. Such performance in favor of urban schools, for instance, must have been borne out of many facilities they were used to which were not available in the rural locations. Awodun and Oyeniyi (2018) reported contrary results.

Umar and Samuel (2018) noted that regardless of the laudable values attached to academic performance, performance among urban and rural students in external examination is still poor regarding school location. Available statistics from West African Examination Council show that students continue to perform poorly in Biology in the May/June examinations. For instance, in 2016, the total percentage of students who attained credit passes and above in Biology was (46.87%) while (53.13%) failed. In 2015, 2016, 2017, 2018 and 2019, the percentage passes recorded in Biology were (33.50%), (35.66%), (52.73%), (57.27%) and (47.39%) respectively while the percentage failure obtained were; (61.50%), (64.34%), (48.27%), (43.83%) and (52.61%) respectively (Olorundare, 2014; WAEC, 2016). In addition, students' performance in Biology in the West African Examination Council (WAEC) report from 2016 to 2020 indicates poor performances; there was no record of (50%) pass. General reports from 2017 showed a raw mean score of 30 and standard deviation of 9.00, 2018 showed a raw mean score of 31 and a standard deviation of 11.92; 2019 with a raw mean score of 31 and standard deviation of 9.41(WAEC Report, 2020). Paul (2014) submitted that many researchers have adduced that poor performance in public examination is traceable to poor instructional delivery by teachers. This is more pronounced in abstract concepts in Biology like genetics.

The mastery of the concept of genetics among students may not be fully achieved without the use of innovative instructional approaches with adequate utilization and application of instructional materials. Itighise and Akpan (2022) found out that mobile handheld devices successfully delivered high level meaningful skills, educational content, lesson and scaffolding. It is therefore important to explore how instructional materials (animation, improvised model and realia) would bridge the gap in students' performance in the concept of DNA in Biology, considering their gender and location of their schools. Thus, the main thrust of this study is to ascertain the effectiveness of DNA animation, improvised model and realia (real life DNA laboratory extraction) in enhancing students' performance in the teaching of DNA in Biology.

Statement of the Problems

Biology is life science and the study of its concepts is necessary for growth, development and betterment of humans and the society at large. The performance of students in the subject and its concepts is supposed to be of high quality so as to be able to utilize the numerous importance of the subject for the good of the society. In spite of the significant role of biology in life, the performance of students in Senior School Certificate Examinations has been experiencing a decline (West African Examination Council, 2016). The annual WAEC Chief Examiners report from 2016 to 2020 has also indicated this low performance (WAEC, 2020). This phenomenon has constituted a source of great concern to stakeholders in education such as students, teachers, parents, school authority, government and the society at large.

Many factors have been blamed for this worrisome situation among which is ineffective application/use of instructional materials adopted by Biology teachers. Teacher centered learning strategy is not likely to bring about high academic performance in students due to lack of students' interaction and teamwork. In teacher-centered learning, students contribution to the instruction is minimal. More so, researchers in the field of Biology education (Fatima, 2015; Olakekan & Oludipe 2016), have continually sought for better innovative instructional delivery strategies that can provide a bridge between unfamiliar concepts and the knowledge which students possess in order to improve students' performance in Biology. Biology, just like any other science subject is influenced by the area in which the school is cited. This affects both the teachers and the learners alike. Hence, the location of a school may determine the academic performance of students.

One of such strategies could be the use of innovative instructional materials during lesson delivery. Innovative instructional materials such as computer animation, improvisation of instructional model/material and real-life situation of laboratory activities could reduce abstraction; enhance better understanding and in-depth knowledge of concepts perceived difficult by the students including genetics. Therefore, as part of the continuous search for improved students' performance in Biology in secondary schools, it is necessary to establish the effectiveness of DNA animation, improvised model and realia (real life DNA laboratory extraction) in enhancing students' academic performance in biology?

Purpose of the Study

The purpose of this study was to:

1. Examine the difference in the performance scores of students taught the concepts of DNA using animation, improvised model, realia and those taught without instructional material in Biology.
2. Establish the difference between urban and rural students' performance scores taught the concept of DNA using animation, improvised model and realia with those taught without instructional material in Biology.
3. Find out the interaction effect of instructional materials (animation, improvised model, realia) and school location on students' performance scores of the concept of DNA in Biology

Research Questions

1. What difference exits in the performance scores of students taught the concept of DNA using animation, improvised model and realia and those taught without instructional material in Biology?
2. What is the difference in the performance scores of urban and rural students taught the concepts of DNA using animation, improvised model and realia with those taught without instructional material in Biology?
3. What is the interaction effect of school location and treatments on students' performance scores on the concept of DNA in Biology?

Hypotheses

1. There is no significant difference in the mean performance scores of students taught the concept of DNA using animation, improvised model and realia with those taught without instructional material in Biology.
2. No significant difference exists in the mean performance scores of urban and rural students taught the concept of DNA using animation, improvised model and realia with those taught without instructional material in Biology.
3. There is no significant interaction effect of school location and treatments on students' mean performance scores on the concept of DNA in Biology.

Methodology

This study employed quasi-experimental pretest posttest control group design. This study in the context of this design employed three experimental groups and a control group. The study was carried out in the three senatorial districts (Uyo, Ikot Ekpene and Eket) of Akwa Ibom State. Population of the study consisted of all the 51,843 students with males accounting for 22,260 and females 29,583 of Senior Secondary Two (SS2) students. A sample size of 879 senior secondary II Biology students drawn from 18 schools in their intact classes through multi stage sampling technique was used for the study. DNA unit test (DNAUT) was used as instrument for data collection. The instrument was duly validated and subjected to reliability analysis using Kuder Richardson 20 (K-R20). The result showed reliability coefficient of 0.83 and was deemed appropriate for the main study (Nenty & Umoinyang, 2004). Descriptive statistics of mean and standard deviation were used in answering the research questions while analysis of covariance (ANCOVA) was used in testing the hypotheses at 0.05 alpha level. The DNAUT was administered to students as pretest and posttest.

The Biology teachers were recruited and instructed to serve as research assistants on the use of the lesson packages for the experimental and control groups (I, II, III and IV) respectively in the respective sampled schools. The lesson package for the experimental group I was designed using DNA animation instructional material with 220 students, experimental group II lesson package was designed also based on improvised model instructional material with 222 students while experimental group III lesson package was based on realia instructional material with 197 students and the control group IV designed also and taught without instructional material with 240 students respectively. There are 391 urban located students in the experimental and control groups while there are 488 rural located students in the experimental and control groups respectively Eight weeks were used to collect data for this study during which the topic DNA were taught. Eighteen intact classes were used in collecting data for the study.

Twelve intact classes from the schools sampled were assigned to experimental group while six was assigned the control group (those taught without instructional material) respectively. The researcher trained all the teachers in the intact classes from the experimental and control groups. The researcher and the research assistants taught the selected concepts to their groups using instructional packages for six weeks. The procedure followed was to train the research assistants alongside give a pretest for two weeks, while the researcher taught the

experimental and control groups of the urban schools, the research assistants also taught the lesson to the experimental and control groups of the rural schools using the instructional packages for two weeks across each of the three senatorial districts concurrently then follow up with the posttest for six weeks. The research procedure lasted for eight weeks. The test was administered by the research assistants under the supervision of the researcher. Pretest and Posttest scripts from the four groups were collected, scored and used for data analysis. The research questions were answered using descriptive statistics of mean and standard deviation while the hypotheses were tested using Analysis of Covariance (ANCOVA) at .05 level significance.

Results

Research Question One: Mean and Standard deviation were used in answering research question one as presented in Table 1

Table 1: Mean and standard deviation of students' pretest and posttest performance mean scores of students' taught the concept of DNA using animation, improvised model and realia and those taught without instructional material in Biology(N=879)

	Pretest			Posttest		
Groups	N	Mean	SD	N	Mean	SD
Animation	220	12.34	2.35	220	33.97	6.48
Improvised	222	12.59	2.22	222	26.88	5.62
Realia	197	12.20	2.41	197	36.74	7.02
Control	240	12.59	2.30	240	15.61	3.84

Source**:** Field work 2023

Table 1 shows that there is a difference in students' performance mean scores when taught the concept of DNA using animation, improvised model and realia and those taught without instructional material in Biology. Students in the experimental groups performed better with a posttest mean of 33.97, 26.88 and 36.74 respectively than students in the control group with a posttest mean of 15.61. But, within the experimental groups, students taught the concept of DNA using realia performed better than students taught with DNA animation followed by improvised model with a mean scores of 36.74, 33.97 and 26.88 respectively.

Research Question Two:

Mean and Standard deviation were used in answering research question three as presented in Table 2.

Table 2: Mean and standard deviation of students' pretest and posttest performance mean scores of urban and rural students' taught the concept of DNA using animation, improvised model and realia and those taught without instructional material in Biology(N=879)

		Pretest			Posttest		
Location	Groups	N	Mean	SD	N	Mean	SD
Urban	Animation	84	12.21	2.49	84	35.29	8.25
	Improvised	98	12.29	2.29	98	27.31	6.42
	Realia	96	12.33	2.69	96	40.76	4.56
	Control	113	12.69	2.23	113	14.39	2.29
Rural	Animation	136	12.39	2.26	136	32.59	5.43
	Improvised	124	12.90	2.13	124	26.48	4.70
	Realia	101	12.13	2.11	101	33.09	6.92
	Control	127	12.45	2.38	127	16.61	4.60

Source**:** Field work 2023

Table 2 indicates the difference between urban and rural mean performance scores of students' taught the concept of DNA using animation, improvised model and realia with those taught without. The result shows that urban and rural students' in the experimental groups (animation, improvised model and realia) with posttest mean scores of (urban; 35.29, 27.31, 40.76 and rural; 32.59, 26.48, 33.09) respectively performed better than their counterparts in the control groups with posttest mean of (urban; 14.39 and rural; 16.61) respectively. But within the experimental groups, the male students performed slightly better than their female counterparts.

Research Question Three:

Mean and Standard deviation were used in answering research question four as presented in Table 3.

Table 3: Mean and standard deviation of the interaction effects of location and treatments on students' mean pretest posttest performance scores of the concept of DNA in Biology(N=639)

		Pretest			Posttest		
Location	Groups	N	Mean	SD	N	Mean	SD
Urban	Animation	84	12.21	2.49	84	35.23	8.25
	Improvised	98	12.29	2.29	98	27.31	6.42
	Realia	96	12.33	2.68	96	40.76	4.56
Rural	Animation	136	12.39	2.26	136	32.59	5.43
	Improvised	124	12.90	2.13	124	26.48	4.70
	Realia	101	12.13	2.11	101	33.09	6.92

Source**:** Field work 2023

The result in Table 3 indicates the interaction effects of treatments and location on students' mean performance scores of the concept of DNA in Biology. The table reveals that urban and rural students' in the experimental group 3 (those exposed with realia instructional material) with posttest mean performance scores of (urban; 40.76 and rural; 33.09 performed better followed by experimental group 1 (those exposed with animation) with posttest mean performance scores of (urban; 35.29 and rural; 32.59) and experimental group 2 (those exposed with improvise model) with posttest mean performance scores of (urban; 27.31 and rural; 26.85) respectively. The results show that the interaction effects of location and treatments given affect significantly the performance of the students in the concept of DNA in Biology.

Hypothesis One:
Analysis of covariance were used in testing hypothesis one as presented in Table 4.

Table 4: Analysis of covariance of students' academic performance in the concept of DNA taught using animation, improvised model and realia with those taught without in Biology (N=879)

Source	Type III Sum of squares	df	Mean Square	F	Sig.
Corrected Model	60271.350[a]	4	15067.838	452.857*	.000
Intercept	18661.363	1	18661.363	560.859*	.000
Pretest	291.033	1	291.033	8.747*	.003
Instructional Material	60266.686	3	20088.895	603.763*	.000
Error	29080.442	874	33.273		
Total	768000.000	879			
Corrected Total	89351.791	878			

*significant at p<.05 alpha level, N=879, df =1 and 874
R Squared =.675 (Adjusted R squared = .673)
Source**:** Field Data

The result in Table 4 indicates that there is a significant difference in the mean performance of students' taught the concept of DNA using animation, improvised model and realia with those taught without instructional materials (F-cal =603.763, p=0.000) with degree of freedom of 1 and 874 at 0.05 alpha level. This implies that the p-value of 0.000 is less than the 0.05 alpha level. The null hypothesis is therefore rejected which means, there is significant difference between the academic performance of students' taught the concept of DNA using animation, improvised model and realia than those taught without instructional material. This implies that animation, improvised model and realia significantly influenced students' academic performance in Biology. The table above also showed a regression index squared of 0.675, indicating that 68% of the total variance in the performance of students' is attributable to the influence of treatments in the concept of DNA in Biology. Therefore, there is a significant difference in the mean performance scores of students' when taught the concept of DNA using animation, improvised model and realia with those taught without instructional material in Biology.

Since there is a statistically significant difference in hypothesis one, post hoc test is presented in Table 4.1

Table 4.1: Multiple comparisons and mean differences in performance by experimental and control groups

(I)Instructional Materials	(J) Instructional Materials	Mean Difference (I-J)	Standard Error	Sig.
Realia	Improvised	9.96	0.57	0.000
	Animation	2.81	0.57	0.000
	Without	21.23	0.56	0.000
Improvised	Realia	-9.96	0.57	0.000
	Animation	-7.15	0.55	0.000
	Without	11.27	0.54	0.000
Animation	Realia	-2.81	0.57	0.000
	Improvised	7.15	0.55	0.000
	Without	18.42	0.54	0.000
Without	Realia	-21.23	0.57	0.000
	Improvised	-11.27	0.54	0.000
	Animation	-18.42	0.54	0.000

*significant at p<.05 alpha level
Source**:** Field Data, 2023

The fisher's LSD Post Hoc test was conducted to determine the group with the significant means and reveals that the group with the most significant difference is realia because it has the highest mean difference when compared with other groups. This implies that realia was better followed by animation and then improvised in students' academic performance in Biology.

Hypothesis Two

Analysis of covariance were used in testing hypothesis three as presented in table 5.

Table 5: Analysis of covariance of the mean performance scores of urban and rural students' in the concept of DNA taught using animation, improvised model and realia with those taught without in Biology(N=879)

Source	Type III Sum of squares	df	Mean Square	F	Sig.
Corrected Model	63527.962[a]	8	7940.995	265.042*	.000
Intercept	18608.439	1	18608.439	621.082*	.000
Pretest	288.836	1	288.836	9.640*	.002
School Location	1103.243	1	1103.243	36.822*	.000
Instructional Material	60867.776	3	20289.259	677.182*	.000
Location* Instructional Material	2731.303	3	910.434	30.387*	.000
Error	26066.347	870	29.961		
Total	64081.000	879			
Corrected Total	89594.309	878			

*significant at p<.05 alpha level, N=879, df =1 and 870
R Squared =.709 (Adjusted R squared = .706)
Source**:** Field Data, 2023

The result in Table 5 showed that there is a significant difference in the mean performance scores of urban and rural students' in the control and experimental groups taught the concept of DNA based on animation, improvised model and realia with those not exposed

with instructional material (F-cal=30.387, p=0.000). The null hypothesis is therefore rejected which means that the performance of urban and rural students who were exposed to treatments in the experimental groups significantly differ from those not exposed on the concept of DNA (p=0.000, p<0.05). The table above also showed a regression index squared of 0.709, indicating that 71% of the total variance in the performance of urban and rural students' is attributable to the influence of treatments in the concept of DNA in Biology. Therefore, there is a significant difference in the mean performance scores of urban and rural students' taught the concept of DNA using animation, improvised model and realia with those taught without in Biology.

Hypothesis Three

Two- way analysis of covariance was used in testing hypothesis five as shown in table 6.

Table 6: Analysis of covariance on the interaction effect of school location and treatments on students' academic performance in the concept of DNA in Biology (N=639)

Source	Types III sum of square	df	Mean Square	F	Sig
Corrected Model	14795.758[a]	6	2465.960	68.824*	.000
Intercept	16898.986	1	16898.786	471.642*	.000
Pretest	457.152	1	457.152	12.759*	.000
School Location	2247.173	1	2247.173	62.717*	.000
Instructional Material	11417.963	2	5708.981	159.335*	.000
Location* Instructional Material	1171.817	2	585.908	16.352*	.000
Error	22644.636	632	35.830		
Total	702379.000	639			
Corrected total	37440.394	638			

*Significant at p<.05 alpha level, N=639, df = 1 and 632
R squared = .395 (Adjusted R squared = .389)
Source: Field Data, 2023

Table 6 indicates that there is a significant difference in student's academic performance in the concept of DNA based on the interaction effect of school location and treatments (F-cal = 16.352, p=0.000). The null hypothesis is therefore rejected which means that there is significant difference in the interaction effects of location and treatments on students' academic performance in the concept of DNA in Biology (p= 0.000, p< 0.05). The table above also showed a regression index squared of 0.395, indicating that 40% of the total variance in the performance of students is attributable to the difference in the interaction effect of school location and treatments in the concept of DNA in Biology. Therefore, there is a significant interaction effect of school location and treatment on academic performance of students in the concept of DNA in Biology.

Discussion of Findings

Concepts of DNA using animation, improvised model, realia and those taught without instructional material on students performance in Biology

The result of the analysis in hypothesis one indicated that animation, improvised model and realia significantly influence students' academic performance than those taught without instructional materials in the concept of DNA in Biology. But within the experimental groups, those taught with realia is more effective in performance followed by animation and improvised model. This is why Akpan (2018) stated that science education research, innovation and practices must become more responsive to the needs and ambitions of the society and reflect its

values. This explains why a major component of the framework for effective curriculum implementation is instructional materials (National Educational Research and Development Council, NERDC, 2015). For this reason, therefore, a good lesson plan must include the identification and deployment of instructional materials by the teacher.

This finding is in agreement with the work of Ogunbanwo (2019) that the effective use of instructional materials has improved students' academic performance. The effective use of instructional materials has improved students' academic performance and also, the teaching of Biology without instructional materials may certainly result in poor academic performance. This work is also in consonance with the works of Osinubi and Okebukola (2014) that adequate use of instructional materials had significantly influence on students' performance in Biology. The teaching of Biology cannot be done effectively without interaction between the teacher, students and the environmental resources.

Urban and rural students taught the concept of DNA using animation, improvised model and realia and those taught without instructional material on students' performance in Biology.

The result of the analysis in hypothesis two indicated that urban and rural students in the experimental groups taught the concept of DNA based on animation, improvised model and realia significantly influence students' academic performance than those taught without instructional material in the concept of DNA in Biology. Students in urban areas taught with instructional material had better academic performance than their rural counterpart. The rural schools tend to have less teaching materials and qualified teachers, functional laboratory facilities and fewer full-time counselors than urban schools. For this reason of shortages in teaching staff in rural schools, teachers in rural schools teach higher number of different classes than their urban counterparts (Olusola & Omotade 2014).

This study confirmed that the urban students in the experimental group have better statistically significant mean scores and greater academic performance than the rural students in the control groups. The urban students taught with instructional materials performed excellently than those who were taught without them. Also, this is in line with the work Umar and Samuel (2018) showed significant difference in Basic Science achievements between urban and rural students when taught with instructional material than their control counterparts. Students in urban schools had better achievement than those at rural settings.

Interaction effect of instructional materials (animation, improvised model, realia) and school location of the concept of DNA on students' performance in Biology

The result of the analysis in hypothesis three indicated that the interaction effect of school location and treatment significantly influence students' academic performance in the concept of DNA in Biology. Poverty of many rural communities (border towns inclusive) reduces parents' capacity to make adequate provisions for their wards and supplement their educational needs with the resources available to jumpstart and increase their desire to learn in the absence of the teacher. This study is in consonance with the work of Abamba (2021) that schools in rural communities are likely to have a preponderance of unqualified teachers a practice that is detrimental to knowledge acquisition. In addition, the remoteness of schools in rural areas makes it almost impossible for education inspectors or quality assurance officers to visit the schools for inspection. Further still, the mere location of a school, some of the time, plays important role in affording learners the opportunity required to master or comprehend what they are taught in school. For example, urban located students' taught with instructional materials afford urban children greater chances of experiencing city life more than the children who live in rural villages.

On the other hand, rural locations afford rural children greater opportunity of experiencing nature more than children who dwell in cities. It is also probable that children in

urban schools will have greater opportunities or situations for expressive use of language than their rural counter parts. Nevertheless, in this study, the differences in rural and urban areas indicated the differences in the academic performance of students in Biology.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Innovative instructional materials and approach should be considered in any classroom and laboratory situation for effective teaching and learning.
2. Principals and school inspectors should insist that teachers plan their instructional materials for teaching and learning and include it in their routine checks.
3. Seminar/workshop should be organized for all science teachers at regular interval to enable them have skills on how to use animation with new emerging technologies, improvise and carryout practical lessons for instruction in the teaching-learning process.

Conclusion

From the findings, it can be concluded that students' taught with realia instructional material based on school location lead to better academic performance followed by animation and improvised model on the part of the students. Also, the interaction effects of location and treatment have a significant effect on students' academic performance in the concept of DNA in Biology.

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