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Application of DNA Animation, Improvised Model and Realia in Teaching and Students' Performance Based on Gender in Biology in Akwa Ibom State, Nigeria.

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Abstract
The study determined the effectiveness of DNA animation, improvised model and realia in enhancing students' performance based on gender 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 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 animation, improvised model and realia in the concept of DNA based on gender 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 gender.

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

Introduction

Education experts all over the world are concerned with how teaching and learning could be organized in order to achieve educational goals of the nation,

especially in this current scientific and technological driven world. Science is most often an exciting and satisfying enterprise that requires creativity, skill and insight. 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, 2013) 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, 2013). 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, Udofia & Etim, 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, we can also define it 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 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. 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). They are used by teachers in classroom to aid in the attainment of specific learning objectives set out in classroom plans (Etop, Iboro & Obogo, 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. 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. The Biology curriculum is planned and designed to enable the teacher use activity oriented, student-centered approach to teach (Oluwaseun, Onovroghene & Avodele, 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, Lameed & Benson, 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, laboratory equipments among others.

Computer animated instructional materials have also proven to be effective in the teaching and learning process. 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). Several studies have highlighted the potential benefits of ICT for improving educational outcomes (Eno, Uko & Utibe, 2023). CAI heavily relies upon the use of ICT components to strengthen the learning processes (Itighise & Wordu, 2016). ICT components, 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. Ezechi (2019) state 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. It was on this ground that Utibe, Uboh and Inyang (2022) observed that the application of improvised instructional materials takes adequate care of the three domains of learning (cognitive, affective and psychomotor) thereby reducing the abstractedness of the scientific concepts. 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.

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 (Oladejo & Ebisin, 2021). Chukwuneke (2016) 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. According to Ezechi (2019) the cost of effectively teaching Biology is so high that Nigeria may not be able to afford at least adequately equipped laboratories and provision of adequate instructional materials for the teaching of practical biology classes. 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. 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 gender can influence how students learn and their academic performance, thus it is important to consider this intervening variable in research in science education. Gender is a socially constructed definition of male and female. Gender is the range

of characteristics pertaining to and differentiating between, masculinity and feminity. National trends revealed mixed result with regard to the gender gap in science performance. In some instances, such as course work completed, female perform equal to male peer; however, assessment geared to measuring mastering of content, such as the National Assessment of Educational progress, reveals that difference between male and female in K-12 education surface in elementary school and continue at the high school level, (Ingels & Dalton, 2016). Differences in school performance at the K-12 level are attributed in part to fewer females attaining degrees in Science, Technology, Engineering and Mathematics (STEM) field. The issue of gender and gender stereotyping permeate all aspects of human endeavors (Umanah and Sunday, 2022).

Asano, Rita, Amponsah, Kwaku Darko, Baah-Yanney, Obed, Quarcoo, Frederick, & Azumah, Delphine Abla., 2021; Utibe and Agwagah, (2015) noted that regardless of the laudable values attached to academic performance, performance among male and female students in external examination is still poor. Akpan (2017) opined that traditional methods of instruction should give way to activity-based, minds-on, hands-on, students-centred strategy that enhances entire learning. 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 2011, 2012, 2013, 2014 and 2015, the percentage passes recorded in biology were 38.50%, 35.66%, 51.73%, 56.17% and 47.39% respectively while the percentage failure obtained were; 61.50%, 64.34%, 48.27%, 43.83% and 52.61% respectively (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, 2017). 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. 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. Researchers in the field of Biology education (Fatima, 2015; Olakekan & Oludipe 2016; Asano, Rita, Amponsah, Kwaku Darko, Baah-Yanney, Obed, Quarcoo, Frederick, & Azumah, Delphine Abla., 2021), 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. More so, gender has been identified as one factor that influences students' academic performance. The issue of gender on students performance has been controversial.

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 determine the effectiveness of DNA animation, improvised model and realia in enhancing students' performance when used to teach the concept of DNA in Biology in secondary schools in Akwa Ibom State, Nigeria. Specifically, this study was to:

1. examine the performance scores of students taught the concepts of DNA using animation, improvised model, realia and those taught without instructional material in Biology.

2. ascertain the difference between male and female students performance scores taught the concept of DNA using animation, improvised model and realia with those taught without instructional material in Biology.

3. determine the interaction effect of instructional materials (animation, improvised model, realia) and gender on students' performance scores of the concept of DNA in Biology

Research Questions

To guide this study, the following research questions were raised and answered in the course of the study:

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 difference exists in the performance scores of male and female students taught the concept of DNA using animation, improvised model and realia with those taught without instructional material in Biology?

3. What is the interaction effect of gender and treatment on students' performance scores of the concept on DNA in Biology?

Null Hypotheses

To guide this study, the following null hypotheses were formulated and tested at 0.05 level of significance.

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 male and female 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 gender 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 groups I, II, and III respectively. The lesson package for the experimental group I was designed using DNA animation instructional material, experimental group II lesson package was based on improvised model instructional material while experimental group III lesson package was based on realia instructional material and the control group taught without instructional material. Pretest was administered to students' in the four groups before treatment started. The treatment lasted for eight weeks after which the DNAUT was reshuffled and administered as posttest to students in the four groups. 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 1: What difference exits in the mean performance scores of students taught the concept of DNA using animation, improvised model and realia and those taught without instructional material in Biology? 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 score of 36.74, 33.97 and 26.88 respectively.

Research Question 2: What difference exists in the mean performance scores of male and female students taught the concept of DNA using animation, improvised model and realia with those taught without instructional material in Biology? Mean and Standard deviation were used in answering research question two as presented in Table 2.

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

			Pretest			Posttest	
Gender	Groups	N	Mean	SD	N	Mean	SD
Male	Animation	110	12.12	2.47	110	35.30	7.74
	Improvised	118	12.53	2.38	118	27.65	6.17
	Realia	93	12.45	2.63	93	40.75	4.48
	Control	110	12.56	2.32	110	15.84	4.07
Female	Animation	110	12.53	2.20	110	31.95	5.12
	Improvised	104	12.74	2.02	104	25.93	4.56
	Realia	104	12.03	2.18	104	39.79	4.66
	Control	130	12.57	2.31	130	15.34	3.65

Source: Field work 2023

Table 2 indicates the difference between male and female mean performance scores of students taught the concept of DNA using animation, improvised model and realia with those taught without. The result shows that male and female students' in the experimental groups (animation, improvised model and realia) with posttest mean scores of (male; 35.30, 27.65, 40.75 and female; 31.95, 25.93, 39.8) respectively performed better than their counterparts in the control groups with posttest mean of (male; 15.84 and female; 15.34) respectively. But within the experimental groups, the male students performed slightly better than their female counterparts.

Research Question 3: What is the interaction effect of gender and treatment on student's mean performance scores of the concept of DNA in Biology? 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 gender and treatmentson students' mean pretest posttest performance scores of the concept of DNA in Biology(N=639)

		Pretest			Posttest		
Gender	Groups	N	Mean	SD	N	Mean	SD
Male	Animation	110	12.12	2.51	110	35.76	7.05
	Improvised	118	12.36	2.26	118	27.60	6.36
	Realia	93	12.39	2.67	93	40.12	4.93
Female	Animation	110	12.57	2.16	110	32.17	5.31
	Improvised	104	12.86	2.16	104	26.06	4.53
	Realia	104	12.04	2.15	104	33.72	7.25

Source: Field work 2023

The result in Table 3 indicates the interaction effects of treatments and gender on students' mean performance scores of the concept of DNA in Biology. The table reveals that male and female students' in the experimental group 3(those exposed with realia instructional material) with posttest mean performance scores of (male; 40.12 and female; 33.72 performed better followed by experimental group 1 (those exposed with animation) with posttest mean performance scores of (male; 35.76 and female; 32.17) and experimental group 2 (those exposed with improvise model) with posttest mean performance scores of (male; 27.60 and female; 26.01) respectively. The results show that the interaction effects of gender and treatments given affect significantly the performance of the students' in the concept of DNA in Biology.

Null Hypothesis 1: There is no 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.

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 also shows 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 mean 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.

Null Hypothesis 2: There is no significant difference in the mean performance scores of male and female students' taught the concept of DNA using animation, improvised model and realia with those taught without instructional material in Biology.
Analysis of covariance were used in testing hypothesis two as presented in Table 5

Table 5: Analysis of covariance of the mean performance scores of male and female 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 Mode	74865.869[a]	8	9358.234	349.593*	.000
Intercept	19634.079	1	19634.079	733.466*	.000
Pretest	300.433	1	300.433	11.223*	.001
Gender	587.482	1	587.482	21.946*	.000
Instructional Material	73694.119	3	24564.706	917.658*	.000
Gender* Instructional Material	288.609	3	96.203	3.594*	.013
Error	23288.956	870	26.769		
Total	810499.00	879			
Corrected Total	98154.826	878			

**significant at p<.05 alpha level, N=879, df =1 and 870*
R Squared =.763 (Adjusted R squared = .761) Source: Field Data, 2023

The result in Table 5 showed that there is a significant difference in the mean performance scores of male and female 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=3.594, p=.013) with the degree of freedom of 1 and 870 at 0.05 alpha level. The null hypothesis is therefore rejected which means that the performance of male and female students who were exposed to treatments in the experimental groups significantly differ from those not exposed on the concept of DNA (p=0.013, p<0.05). The table also shows a regression index squared of 0.763, indicating that 76% of the total variance in the performance of male and female students' is attributable to the influence of treatments in the concept of DNA in Biology. Therefore, there is significant difference in the mean performance scores of male and female students' taught the concept of DNA using animation, improvised model and realia with those taught without instructional material in Biology.

Hypothesis 3: There is a significant interaction effect of gender and treatment on academic performance of students in the concept of DNA in Biology. Two-way analysis of covariance was used in testing hypothesis four as shown in Table 6.

Table 6: Analysis of covariance on the interaction effects of genders 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	14380.428 [a]	6	2396.738	67.349*	.000
Intercept	16517.494	1	16517.49	464.148*	.000
Pretest	509.332	1	509.332	14.312*	.000
Gender	2438.511	1	2438.511	68.523*	.000
Instructional Material	11700.356	2	5850.178	164.392*	.000
Gender* Instructional Material	530.538	2	265.269	7.454*	.001
Error	22490.787	632	35.587		
Total	706010.000	639			
Corrected total	36871.214	638			

**Significant at p<.05 alpha level, N=639, df = 1 and 632*
R squared = .390 (Adjusted R squared = .384, Source: Field Data, 2023

Table 6 indicates that there is a significant difference students' academic performance in the concept of DNA based on the interaction effects of gender and treatments. (F-cal = 7.454, p =0.001) with degree of freedom of 1 and 632 at 0.05 alpha level. The null hypothesis is therefore rejected which means that there is a significant difference in the interaction effect of gender and treatments on the academic performance of students' in the concept of DNA in Biology (p = 0.001, p< 0.05). The table also shows a regression index squared of 0.390, indicating that 40% of the total variance in the performance of students in attributable to the difference in the interaction effect of gender and treatments in the concept of DNA in Biology. Therefore, there is a significant interaction effect of gender and treatment on academic performance of students in the concept of DNA in Biology.

Discussion of Findings

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 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 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.

The result of the analysis in hypothesis two indicated that male and female 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. Gender difference existed in performance of male and female students when exposed to instructional material in favor of the male students than their control counterparts. Several reasons for the varied conclusion among others but one is the subject on which the gender equality is being measured on. For example, there has been global concern about gender differences in students' performance in Biology and some researches have been undertaken in many parts of the globe in this respect.

The result of the analysis in hypothesis three indicated that the interaction effect of gender and treatments significantly influence students' academic performance in the concept of DNA in Biology. Also, this work is in contrast with the work of Olakekan & Oludipe (2016) that there is no significant interaction effect of gender and treatment with regards to students' academic performance. Umanah & Sunday (2022) opined in there work that there is no significant difference in the mean performance scores of male and female students, hence, instructional strategy is gender friendly.

1. should be organized for all science teachers at regular intervals 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 gender lead to better academic performance followed by animation and improvised model on the part of the students. Also, the interaction effect of gender and treatment has a significant effect on students' academic performance in the concept of DNA in Biology.

Recommendations

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

2. Innovative instructional materials and approach should be considered in any classroom and laboratory situation for effective teaching and learning.
3. Principals and school inspectors should insist that teachers plans their instructional materials for teaching and learning and include it in their routine checks.

Serminar/workshop

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