EFFECT OF IMPROVISED DNA MODEL AND FLIP CHART ON STUDENTS' PERFORMANCE AND RETENTION IN BIOLOGY IN EKET LOCAL GOVERNMENT AREA, AKWA IBOM STATE.

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Abstract

The study investigated the effect of improvised DNA model and flip chart on students' academic performance and retention in Biology in Eket Local Government Area. Five research questions and five null hypotheses were formulated to guide the study. Quasi-experimental design consisting of pre-test, post-test non-equivalent control group adopted for the study. The population consisted of 1,338 Senior Secondary One (SS1) Biology students from all public co-educational secondary schools in Eket Local Government Area for the 2023/2024 session. The sample size consisted of one hundred and two (102) senior secondary three (SS1) Biology students. A purposive sampling technique was used to select two co-educational secondary schools in the study area. The two schools selected were randomly assigned to experimental and control groups by tossing a coin. Students in the experimental group were taught the concept of genetics using an improvised DNA model, while students in the control group were taught the concept of genetics using a flip chart. The instruments used for data collection were the Biology Performance Test (BPT) and the Biology Retention Test (BRT) designed by the researcher. Analysis of Covariance (ANCOVA) was used to test hypotheses at a 0.05 level of significance. The findings revealed that there was a significant difference in the mean performance of Biology students taught genetics using improvised DNA model and flip chart in favour of students taught using improvised DNA model; there was no significant difference in the mean performance and retention scores of male and female Biology students taught genetics using improvised DNA model and flip chart. It was concluded that the use of an improvised DNA model is an effective method in improving students' academic performance in Biology. It was therefore recommended that Biology teachers should consider implementing the improvised DNA model as the primary teaching method as it showed significantly better results in students' academic performance.

Keywords: Improvised DNA model, flip chart, retention, gender and Biology students.

Introduction

Biology occupies a very important position in the secondary school curriculum. It is designed to prepare students to acquire adequate knowledge and skills in Biology and apply it to everyday life in matters of personal, community, health and agriculture among others. Obiadazie, Nwajoko and Obi(2020) noted that there is high enrolment in Biology during external examinations. Bichi, Ibrahim and Ibrahim (2019) noted that regardless of the high number of students enrolled in Biology in senior secondary school examinations conducted by West African Examination Council (WAEC) and National examination Council (NECO), students' performance in external examination is still poor. In addition to the aforementioned, the reports of the WAEC Chief Examiner (2019-2023) indicated poor performance in Biology with particular reference to questions in genetics. The poor performance of the candidates in the

subject was attributed to the following weaknesses which were recurrent: Candidate's showing poor understanding of the demands of the questions; poor understanding of certain terms in genetics e.g. pure-breeding, nucleotide, hybrid, dominant and recessive characters and drawing of wrong genetic diagrams (Ndayambaje, Bikorimana & Nsanganwimana, 2021; Bessong et al, 2023).

Available statistics from West African Examination Council indicated that students' performance in Biology in the May/June examinations (2019- 2023)was unimpressive. In 2019, 2020, 2021, 2022 and 2023 the percentage passes recorded in Biology were50.92%, 51.16%, 53.81%, 56.36% and 59.81% respectively while the percentage failure obtained were 49.08%, 48.84%, 46.19%, 43.64% and 40.19% respectively. This consistent poor performance of students in Biology shows that majority of the students who enrolled for Biology in external examinations graduate without grasping the fundamentals of the subject especially in the concept of genetics.

Genetics is a concept in Biology that studies the process or mechanism of heredity. It focuses on establishing the scientific basis for understanding of how characteristics or traits are transfered from parents to their offspring or from one generation to another. In genetics, students learn certain aspects of gene and their mode of transmission from generation to generation. Such knowledge help students understand problems of genetic nature rather than relying on superstition and other mystical explanations (Edet, 2017; Adie et al, 2020, Olofu et al, 2019). Students also learn accurate scientific ways of explaining the genetic defects that may be found in their families and communities. Despite the importance of genetics, the make-up of humans, it is disheartening to note that students' performance at the secondary school certificate examination in Nigeria in questions related to the concept of genetics has been poor and unimpressive (Bichi, Ibrahim & Ibrahim, 2019). This may be due to the abstract nature of the concept of genetics, lack of instructional materials and ineffective methods of teaching (Bessong et al, 2024; Adie et al, 2019; Olofu, et al 2017).

Research reports by Akpan (2022) and Aziz, Sibilana, Supangken and Muniri (2021) have shown that most teachers prefer to teach Biology without the use of relevant instructional materials. This invariably leads to poor performance in the subject. For effective teaching and learning of abstract concepts such as genetics, instructional materials play a very important and significant role in promoting teachers' efficiency and enhancing students' academic performance (Itighise & Umanah, 2019; Arop, Umanah & Effiong, 2015). Instructional materials are the resources used by teachers and learners during the teaching-learning process to facilitate understanding, enhance engagement, and improve academic performance. These materials can be physical or digital and are designed to support the delivery of lesson content, clarify concepts and provide practical or visual reinforcement of ideas (Umanah & Atabang, 2025). Instructional materials make learning more interesting, practical, realistic, appealing and enable teachers and students to participate actively and effectively in the teaching-learning process (Olayinka, 2016; Itighise, 2018; Akpan & Itighise, 2019; Atabang, 2024, Olofu et al, 2017). Different instructional materials could be used by teachers to enhance students' academic performance. However, this study is focused on the use of iimprovised DNA model and charts as instructional materials in teaching the concept of genetics in Biology.

DNA is an acronym for Deoxyribonucleic Acid. It is a concept in genetics which implies; a self-replicating material present in all living organisms as the carrier of genetic information. Improvised DNA model is a model that helps the students to understand the structure of DNA under the guidance of the teacher. It is made up of three subunits: the phosphate group, the deoxyribose sugars and the base pairs. This model resembles a double helix because two long strands twist around each other like a twisted ladder. The rails of the ladder are made up of alternating sugar and phosphate groups, while the steps of the ladder are made up of two bases joined together by hydrogen bonds. To remove abstraction and bring the topic to the

understanding of students, beads of different sizes and colours are used to represent the three subunits (the phosphate group, the deoxyribose sugars and the base pairs) and the hydrogen bonds. The model is held by a wooden frame (Udoh, 2022). The improvised DNA model can enable students to understand the structure of DNA and how it is ideally suited to encode information that can be faithfully replicated.

Flip chart is an instructional material that does not require projection for viewing. It is extensively used in classrooms for the teaching of concepts that are difficult to understand using verbal codes only. Flip chart is used in teaching and learning process for explanation, illustration, clarification, and reinforcement of certain points in specific lessons. Aziz, Sibilana, Supangken and Muniri (2021) stated that flip chart, when use in an appropriate context with highly effective teaching method gives a positive effect on learning outcomes in thematic subjects, concepts or a set of relationships thus enhancing students' understanding of difficult concepts like genetics.

Udoh (2022) conducted a study on improvised DNA model, realia, virtual reality and Biology students' interest, academic achievement and retention in genetics in Akwa Ibom State using a quasi-experimental design, specifically, a non-randomised pretest-posttest control group design. The population for the study comprises all 9,082 Biology students. The simple size of 255 SS3 Biology students from four (4) intact classes in four (4) schools was drawn purposively through a multi-stage sampling technique. The Biology Interest Scale in Genetics (BISIG) and the Biology Achievement Test in Genetics (BATIG) were the instruments used to collect data for the study. Biology Retention Test (BRTIG) was the reshuffled form of BATIG used for retention measurement. Both instruments were validated by three (3) lecturers from the Department of Science Education, Michael Okpara University of Agriculture, Umudike. Reliability coefficients of .83 and .84 were obtained through Cronbach's alpha (A) and Kuder-Richardson formula-20 (KR–20) for BISIG and BATIG, respectively. Mean, Standard deviation and graphical representation of interaction were used to answer research questions, while Analysis of Covariance (ANCOVA) was used to test hypotheses at the.05 level of significance. Results of findings showed that there was a significant difference among Biology students taught with instructional resources (improvised DNA model, realia, virtual reality and Biology textbook). Students taught with an improvised DNA model, realia, and virtual reality resources had higher interest, academic achievement and retention when compared with students taught with a Biology textbook. The study also showed that gender was not a significant determinant of students' academic achievement and retention in Biology. Based on the findings, recommendations were made among which is the need for Biology teachers to adopt and make effective use of (improvised DNA model, realia, virtual reality) as instructional resources in teaching DNA in genetics; Biology teachers should also encourage both male and female students in learning genetics sincethey can benefit equally from science instructions depending on the involvement of individual student.

Gender is one of the factors that influence students' performance in science in senior secondary school. It is a concept that calls for research review from time to time (Umanah, 2024). Gender is a psychological term describing behaviour and attributes expected of individuals on the basis of being male or female, (Umanah& Sunday, 2022; Umanah&Akpan, 2024). Itighise and Akpan (2022) reported that male and female Science Education students had similar performance mean score in utilization of mobile handheld device in teaching and learning process. Gender differences in students' performance have been of great concern to educators, yet research findings have been inconsistent. Some researchers are of the opinion that female students perform academically better than the male students, others found the opposite; on the other hand, other researchers Akpan and Akpan (2017) and Akpan (2022) found no differences at all between the female and the male students' academic performance.

Another variable considered in this study is students' knowledge retention. Retention is the ability of students to recall information or knowledge gained after learning (Umanah & Akpan, 2024). Numgwo, Emmanuel and Joseph (2016) also define retention as the ability to elicit performance and hold such performance after duration of time. Retention is a very vital component of the learning process which tells the worth of a student in the subjects' areas in terms of skills and knowledge acquired over time. Retentionis the ability to store information which can be easily recalled from the short-term memory and long-term memory. Several studies have reported that instructional materials have influence on retention ability of students (Jude, 2022; Adamu, 2021; Arop, Umanah & Effiong, 2015). Instructional materials help to facilitate comprehension as well as ensure long-term retention of ideas and topics taught to students (Sale, 2016). This study therefore investigated the effects of an improvised DNA model and flip chart on students' performance and retention in Biology in Eket Local Government Area, Akwa Ibom State.

Statement of the Problem

Despite the importance of Biology, students' academic performance in Biology external examinations has been poor and unimpressive. This poor performance generates a lot of concern among parents, teachers, students, and other stakeholders in the education sector. Researchers have identified the concept of genetics as one of the Biologytopics perceivedto be abstract and difficult for students and even teachers. As a result, students shy away from answering questions on genetics during external examinations such as WAEC, those who attempt questions in this topic perform poorly, consequently leading to poor performance in Biology. The need to readdress and proffer a solution to this poor academic performance necessitated this study. The question now is: will the use of improvised DNA model and flip chart enhance students' academic performance in the concept of genetics? Hence,this study examined theeffects of improvised DNA model and flip chart on students' academic performance and retention in Eket Local Government Area.

Purpose of the Study

The purpose of this study was to investigate the effect of improvised DNA model and flip chart on students' performance and retention in Biology. Specifically, the objectives of the study are as follows:

1. to determine the mean performance score of Biology student taught genetic using improvised DNA model and flip chart .
2. to determine the differences in Biology students' retention when taught genetics using improvised DNA model and flip chart.
3. to find out the difference in male and female Biology students' performance when taught genetics using improvised DNA model and flip chart
4. to compare the difference in male and female Biology students' retention when taught genetics using improvised DNA model and flip chart
5. to determine the interaction effect of improvised DNA model, flip chart and gender on Biology students' performance in genetics.

Research Questions

To guide this study, the following research questions were raised:

1. What is the different in the mean performance score of Biology student taught genetic using improvised DNA model and flip chart?
2. What difference exists in the mean retention scores of Biology students taught genetics using improvised DNA model and flip chart?

3. What is the difference in the mean performance scores of male and female Biology students taught genetics using improvised model and flip chart?
4. What is the difference in the mean retention scores of male and female Biology students taught genetics using improvised DNA model and flip chart?
5. What is the interaction effect of improvised DNA model, flip chart and gender on Biology students' performance in genetics in Biology?

Hypotheses

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

1. There is no significant difference in the performance scores of Biology students taught genetics using improvised DNA model and those taught using flip chart.
2. There is no significant difference in the retention scores of Biology students taught genetics using improvised DNA model and those taught using flip chart.
3. There is no significant difference in the performance scores of male and female Biology students taught genetics using improvised DNA model and flip chart.
4. There is no significant difference in the mean retention scores of male and female Biology students taught genetics using an improvised DNA model and a flip chart.
5. There is no interaction effect of the improvised DNA model, flip chart and gender on students' performance in the concept of genetics in Biology.

Methodology

The study adopted a quasi-experimental research design of a non-randomised pretest, posttest control group design. The study was carried out in the Eket Local Government Area of Akwa Ibom State, Nigeria. Eket Local Government Area is located in the South-South geopolitical zone and is one of the oil-producing Local Governments in Akwa Ibom State. It occupies the south-central territorial. The population of the study comprised 1,993 senior secondary one (SS1) Biology students in all public co-educational secondary schools in Eket Local Government Area for the 2023/2024 session. A sample size of 102 senior secondary one (SS1) Biology students, consisting of 56 male and 46 female students, constituted the sample for the study. Purposive sampling technique was used to select two co-educational public schools in the study area, which were randomly assigned into experimental and control groups, respectively, by the toss of a coin. Two instruments used for data collection, were the Biology Performance Test (BPT) and the Biology Retention Test (BRT). The instrument was subjected to face and content validation by experts in Biology. The content validity of the instrument ensured that the test blueprint was appropriately followed. The reliability of the research instrument was determined using the Kuder Richardson-20 (KR-20) formula with reliability coefficient of 0.93 and 0.87 Analysis of Covariance (ANCOVA) was used to test hypotheses at the 0.05 level of significance.

Results

The result of the study was based on hypothesis using Analysis of Covariance (ANCOVA) at 0.05 level of significance.

Hypothesis 1

There is no significant difference in the mean performance scores of Biology students taught genetics using improvised DNA model and those taught using flip chart.

Table 1: Analysis of Covariance (ANCOVA) of the significant difference in the mean performance scores of Biology students taught genetics using improvised DNA model and students taught using flip chart

Source	**SS**	**df**	**MS**	**F_{cal}**	**P-$value_{cal}$**
EG vs CG	143.13	1	143.13	4.53	0.037
Pretest	215.51	1	215.51	6.83	0.011
Error	945.35	44	21.69		
Total	1313.00	46			

S = Significant at .05 level of significance

As shown in Table 1, the calculated p-value (0.037) is less than the significant level (.05). This implies that there exists a significant difference in the mean performance of Biology students taught genetics using improvised DNA model and those taught using flip chart. Therefore, the null hypothesis is rejected, there is significant difference in the mean performance scores of Biology students taught genetics using improvised DNA model and those taught using flip chart.

Hypothesis 2

There is no significant difference in the mean retention scores of Biology students taught genetics using improvised DNA model and those taught using flip chart.

Table 2: Analysis of Covariance (ANCOVA) of the significant difference in the mean retention scores of Biology students taught genetics using improvised DNA model and those taught using flip chart.

Source	SS	df	MS	F_{cal}	P-$value_{cal}$
EG vs CG	121.19	1	121.19	3.53	0.067
Pretest	197.31	1	197.31	5.73	0.021
Error	833.50	44	18.93		
Total	1152.00	46			

NS = Not Significant at .05 level of significance

As shown in Table 2, the calculated p-value (0.067) is greater than the significant level (.05). This implies that there exists no significant difference in the mean retention scores of Biology students taught genetics using improvised DNA model and those taught using flip chart. Therefore, the null hypothesis is retained, there is no significant difference in the mean retention scores of Biology students taught genetics using improvised DNA model and those taught using flip chart.

Hypothesis 3

There is no significant difference in the mean performance scores of male and female Biology students taught genetics using improvised DNA model and flip chart.

Table 3: Analysis of Covariance (ANCOVA) of the significant difference in the mean performance scores of male and female Biology students taught genetics using improvised DNA model and flip chart.

Source	SS	df	MS	F_{cal}	P-value$_{cal}$
EG vs CG	103.15	1	103.15	3.23	0.079
Pretest	201.41	1	201.41	6.29	0.015
Gender	12.56	1	12.56	0.39	0.535
Error	931.29	43	21.65		
Total	1047.00	45			

NS = Not Significant at .05 level of significance

As shown in Table 3, the calculated p-value (.079) is greater than the significant level (.05). This implies that there exists no significant difference in the mean performance scores of male and female Biology students taught genetics using improvised DNA model and those taught using flip chart. Therefore, the null hypothesis is retained, there is no significant difference in the mean performance scores of male and female Biology students taught genetics using improvised DNA model and flip chart.

Hypothesis 4

There is no significant difference in the mean retention scores of male and female Biology students taught genetics using improvised DNA model and flip chart.

Table 4 Analysis of Covariance (ANCOVA) of the significant difference in the mean retention scores of male and female Biology students taught genetics using improvised DNA model and flip chart.

Source	SS	df	MS	F_{cal}	P-value$_{cal}$
EG vs CG	95.61	1	95.61	2.83	0.099
Pretest	193.19	1	193.19	5.63	0.022
Gender	15.29	1	15.29	0.45	0.506
Error	859.10	43	20.02		
Total	970.00	45			

NS = Not Significant at .05 level of significance.

As shown in Table 4, the calculated p-value (.099) is greater than the significant level (.05) This is implies that there exists no significant difference in the mean retention scores of male and female Biology students taught genetics using improvised DNA model and those taught using flip chart. Therefore, the null hypothesis is retained, There is no significant difference in the mean retention scores of male and female Biology students taught genetics using improvised DNA model and flip chart.

Hypothesis 5

There is no interaction effect of improvised DNA model, flip chart and gender on Biology students' performance in genetics.

Table 5: Analysis of Covariance (ANCOVA) of the interaction effect of improvised DNA model, flip chart and gender on Biology students' performance in genetics.

Source	SS	df	MS	F_{cal}	P-value$_{cal}$
EG vs CG	105.19	1	105.19	3.29	0.075
Pretest	200.39	1	200.39	6.23	0.016
Gender	14.13	1	14.13	0.44	0.509
EG vs CG vs Gender	21.98	1	21.98	0.69	0.411
Error	924.70	42	22.02		
Total	1066.00	45			

NS = Not Significant at .05 level of significance

As shown in Table 5, the calculated p-value (.075) is greater than the significant level (.05). This implies that there exists no significant interaction effect of in improvised DNA model, flip chart and gender on students' performance in genetics. Therefore, the null hypothesis is retained, there is no interaction effect of improvised DNA model, flip chart and gender on Biology students' performance in genetics.

Discussion of the Findings

Hypothesis one ascertained the difference in the mean performance scores of Biology students taught genetics using an improvised DNA model and flip chart instructional materials. Students taught using an improvised DNA model had a higher mean gain. This shows that the improvised DNA model has a greater effect on Biology students' performance in genetics than the flip chart. This is supported by Udoh (2022) stated that improvised DNA model when use in an appropriate context has higher academic achievement and result to a positive effect on learning outcomes concepts like genetics.

In hypothesis two, the result showed that there was a significant difference in the mean retention scores of Biology students taught genetics using an improvised DNA model and those taught using a flip chart, with those taught using an improvised DNA model having a higher mean gain. This showed that the improvised DNA model has a greater effect on Biology students' retention in genetics than the flip chart. This finding could be attributed to the fact that the improvised model créate real life situation in enhancing the retention abilities of students in Biology. This is in line. This is in line with Atabang and Umanah (2024) that Basic Science and Technology students taught using Computer Animation with Narration maintain higher retention abilities.

In hypothesis three, the results showed that there was no significant difference in the mean performance scores of male and female Biology students taught genetics using an improvised DNA model and a flip chart. This means that gender was not a significant determinantof Biology students' performance in genetics. This agrees with Itighise and Akpan (2022) that male and female students had similar mean performance scores. This implies that the improvised DNA model and the flip chart instructional materials were gender-friendly.

Hypothesis four showed that there was no significant difference in the mean retention scores of male and female Biology students taught genetics using an improvised DNA model and a flip chart. This means that gender was not a significant determinant ofBiology students' retention in genetics. This was supported by Itighise and Umanah (2019) that the improvised DNA model and the flipped classroom instructional model were gender-friendly, as these materials affected learning equally, ensuring that both male and female students'academic performance was improved.

Hypothesis five showed that there was no significant interaction effect of the improvised DNA model, flip chart and gender on Biology students' performance in genetics. This agrees with Edet (2017) that the utilisation of innovative instructional materials,such as an improvised DNA model promotes student academic performance in Biology.

Conclusion

Based on the findings, it was concluded that the use of an improvised DNA model significantly enhanced students' academic performance in the concept of genetics in Biology. The study also indicated that gender has no significant influence on the performance of Biology students taught genetics using an improvised DNA model and a flip chart. Both the iimprovised DNA model and flip chart instructional materials enhanced students' academic performance in genetics in Biology.

Recommendation

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

1. Biology teachers should be encouraged to use improvised DNA model as instructional material in teaching the concept of genetics in Biology to enhance students understanding and academic performance.
2. Biology teachers should be provided with professional development opportunities to enhance their skills in using the improvised DNA model and other effective learning materials. Training of these teachers could be done by the Government or relevant professional bodies like Science Teachers Association of Nigeria (STAN) through seminars, workshops and conferences.
3. Curriculum planners should include improvised DNA models and flip charts as effective teaching materials for teaching the concept of genetics for optimal student learning outcomes.

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