

## Effects of Improvised De-Oxyribonucleic Acid and Realia Instructional Resources on Biology Students' Interest in Genetics in Uyo municipality, Nigeria

Udoh, Nsimeneabasi Michael<sup>1</sup> & Ndirika, Maryann C.<sup>2</sup>

<sup>1</sup>Department of Science Education, University of Uyo, Uyo, Akwa Ibom State, Nigeria

<sup>2</sup>Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria

**Corresponding Author:** nsimikudoh@yahoo.com

### Abstract

The study investigated effects of improvised de-oxyribonucleic acid and realia instructional resources in Biology students' interest in genetics. Three research questions and three null hypotheses were formulated and tested at 0.05 level of significant using non-equivalent control group quasi-experimental design. The population was 4,598 and the sample size was 162 SS3 students. Students were assigned into experimental and control groups using simple random sampling technique. Biology Interest Scale in genetics (BISIG) with a reliability coefficient of 0.83 was used using Cronbach Alpha. Data were analyzed using descriptive analysis and ANCOVA. Findings showed that students taught with improvised de-oxyribonucleic acid and realia resources had a significantly higher interest than those taught using Biology textbook. No significant difference was found between the mean interest scores of male and female Biology students. Recommendation was that Biology teachers should make use of improvised de-oxyribonucleic acid and realia instructional resources in the teaching of genetics.

**Keywords:** Improvised De-oxyribonucleic acid, Realia, Instructional resources, Students' interest, Genetics

### Introduction

In most Nigerian secondary schools, Biology students viewed the concept of genetics as difficult and this is reflected in poor academic achievement in public senior secondary schools' examinations, West African Examination Counsel (WAEC, 2022). This has become a major concern to educators, parents and even students themselves. To address this issue, emphasis have been made on appropriate and proper use of instructional resources for teaching since it could give first hand personal experience to students and eliminate the abstractness of concepts in Biology.

Biology is the scientific study of living organisms. It primarily deals with the structure, function, growth, evolution and distribution of organisms. Biology as one of the branches of science is the study of living organisms, both plants and animals, and their interaction with environment (Sambo & Sunday, 2024). Because of its importance and indispensability, much emphasis has been placed on Biology as a subject and its instruction at the secondary school level. Udoh, Umoh and Udo (2020) reported that the learning of Biology equips learners with knowledge and skills that help them to face challenges in society especially those related to common diseases, pollution and genetics.

Genetics is a branch of Biology which studies information systems in an organism. It is the study of genes, genetic variation, functions and how traits are passed from parents to their offspring in living organisms. According to Onasanya (2023), genetics is a science of heredity that deals with resemblances and differences of related organisms resulting from the interaction of their genes and the environment arranged linearly along long chains of DNA base-pair sequences. The passing of traits from parents to offspring is known as heredity; therefore, genetics is the study of heredity. Researches show that genetics help students to understand certain aspects of gene, their mode of transmission from generation to generation and

problems of genetic nature, rather than relying on superstition and other mystical explanations, students learn accurate scientific ways of explaining the genetic defects that may be found in their families and communities. The sub themes found under genetics as highlighted by Onasanya (2023) are principles of heredity, variation, differences that occur within the individuals of a specie and the transmission of inheritable characters from parents to their offspring via Deoxyribonucleic Acid (DNA) in genes.

Deoxyribonucleic Acid (DNA) is the information molecule and it is located in the nucleus of every cell in the human body. It stores instructions for making other large molecules, called proteins. These instructions are stored inside the cells, coiled into structural units called chromosomes that contain all of human genetic information. Humans have 46 chromosomes in each of their cells: 23 from mother and 23 from father. Human chromosomes contain smaller segments called genes that determine human physical traits such as two arms, legs, eyes among others. Other characteristics are more specific, such as curly or straight hair, attached or detached earlobes among others. Edet, 2(024) opined that since genetics is a very important aspect of Biology and it is a difficult concept, it requires the use of appropriate instructional resources in the teaching and learning process.

Instructional resources are collection of materials including animate and inanimate objects, human and non-human resources that a teacher may use in the teaching and learning situations to help achieve desired learning objectives. According to Kaspar and Borgerding (2017), instructional resources refer to those equipment and materials that a teacher uses to illustrate, explain and emphasize a lesson, thus, making the lesson clear to the students. Bably and Nusrat (2017) noted that those equipment and materials range from objects that students are familiar with and can be obtained locally to the sophisticated industrial products

which cannot be obtained locally. Instructional resources may aid a student in concretizing a learning experience so as to make learning more exciting, interesting and interactive. Adewale (2022) and Onasanya (2023) opined that instructional resources are the tools a teacher uses in educational lessons to help him teach his students effectively. Onasanya (2023) added that some instructional resources can be teacher-centered such as the use of biology text books.

Biology textbook refers to the traditional teaching resource which is teacher-centered, with the teacher being the controller of the learning environment. It is mainly authoritarian in nature whereby teaching– learning is not based on hands-on activities. In this teaching resource, teachers often taught the way they were taught sometimes using the same textbooks and notebooks they used as students. According to Akpan and Udoh (2022), teachers are expert information providers while the students learn by rote, memorize, regurgitate facts and prepare to reproduce the facts during examinations. Sambo and Sunday (2024) added that the use of biology textbook in science teaching is not an activity-based and it is on the assumption that students are passive subjects that store what they learnt as a result of repeated practice and reinforcement which can be replaced with the use of visual instructional resources such as improvised DNA model and realia.

Improvised Deoxyribonucleic acid (DNA) model is a visual instructional resource that a teacher may use in the teaching and learning of genetics that could help the students to discover the structure of DNA under the guidance of the teacher. It is one of the visual instructional resources that could be used as substitutes for standard resource for the purpose of teaching the concepts of DNA. Improvised DNA model could be made into 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. In the improvised DNA model, beads of different sizes and colours can be used to represent the three subunits (the phosphate group, the de-oxyribose sugars and the base pairs). It can also be used to represents the hydrogen bonds. The improvised DNA model can be held by a wooden frame. Edet (2024) added that improvised DNA model can enable students to understand the structure of DNA and how it is ideally suited to encode information that can be replicated. DNA can also be made from local resources in form of realia for the teaching and learning process.

Realia refers to objects or items from real life used as instructional resources which have the potential to address the problems of effective teaching and learning in Biology. It is another visual instructional resource that a teacher may use in the teaching and learning of genetics that could help the students to discover the structure of DNA and component under the guidance of the teacher through the help of a compound microscope. They are instructional resources used in teaching to sharpen students' observation skills and foster interest in learning. Okorie (2020) stated that realia are real objects or specimens which are readily available or accessible and could be employed by science teachers in the teaching and learning of science

concepts. They are instructional resources whose primary functions are to facilitate the teaching of skills, facts, concepts, principles, generalizations, values and attitude in science. Realia are important visual teaching aids which are used to facilitate and enhance science teaching and learning. Since students may forget the topic of the lesson but will not forget the illustrations used in demonstrating the exercise, the use of realia as instructional resource could enhance students' interest, (Udoh & Ekon, 2018).

Students' interests refer to an attitude expressing concentration, attention and persistence of activity towards a particular subject. Students' interests play an important role in the teaching/learning processes and it is used to designate what attracts an individual to various objects, persons, course and activities within the person's environment. Edet (2024) opined that when a learning task is set before the students, the aptness in responding to the set learning task is centrally controlled by interest. Etiubon and Udoh (2017) added that in the field of education, interest has been the pivot that enables a student to be actively involved in any course of study. Godspower-Echie and Wisdom (2019); Udoh, Umoh, and Udo (2020) stated that the extent to which a student is interested in a particular course of study is indicated by the student's active participation in the study of the subject with resultant good performance in same. Student's interest is what every teacher in any field of study strives to obtain in order to transfer learning to the learners. Cakir (2017) found a significant difference in the interest of Biology students on genetics because interest promotes intrinsic motivation which has been shown to drive and sustain students' engagement in a particular task. He added that the extent to which the student is interested in a particular course of study is indicated by active participation in the study with good performance. Breckler, Christensen and Sun (2019); Ajayi and Ogbeba (2017); Godspower-Echie and Wisdom (2019) found no significant difference on students' interest when taught science concepts. From the review of empirical studies, it is revealed that instructional resources have been proven to be effective in enhancing students' interest. However, no study, known to researcher, has compared effects of improvised DNA, realia and Biology textbook on students' interest in genetics. Therefore, the study seeks to find out if students' interest in Biology can be enhanced with the use of improvised de-oxyribonucleic acid and realia instructional resources which could affect both male and female students in Biology.

Gender refers to the characteristics of women, men, girls and boys that are socially constructed. These include norms, behaviours and roles associated with being a woman, man, girl or boy, as well as relationships with each other (Ajayi & Ogbeba, 2017). It is either of the two sexes (male and female), especially when considered with reference to biological, social and cultural differences. Gender issue in education with academic achievement and retention have become very important issue among researchers. Some research works have shown contradicting evidences in students' academic achievement in science due to gender. For instance, Amedu (2020); Ndirika and Udoh (2019) found out that there is no significant influence in the academic achievement of male and female Biology students but Udoh, Anidu and Ekon, (2024) reported that there are significant gender

differences in students’ academic achievement and retention in sciences. Ekeh (2024) observed that male students achieved and retained significantly better than their female counterparts in mathematics when taught using iconic models. The issue of gender in science achievement of students has not yet been resolved particularly in relation to Biology; hence, the need for further study on the influence of gender on students’ interest in genetics with the use of improvised DNA model and realia in senior secondary schools.

**Research Questions:**

The following research questions were raised to guide this study.

1. What is the difference in the mean interest scores of Biology students taught genetics using improvised DNA model, realia and Biology textbook instructional resources?
2. What is the difference in the interest scores of male and female Biology students taught genetics using improvised DNA model and realia instructional resources?
3. What is interaction effect of instructional resources (improvised DNA model, realia, Biology textbook) and gender on Biology students’ interest on the concept of genetics?

**Research Hypotheses:**

The following null hypotheses were formulated and tested at 0.05 level of significance to guide the study.

1. There is no significant difference in the mean interest scores of Biology students taught genetics using improvised DNA model, realia and Biology textbook instructional resources?
2. There is no significant difference in the mean interest scores of male and female Biology students taught genetics using improvised DNA model and realia instructional resources?
3. There is no significant interaction effect of instructional resources (improvised DNA model, realia, Biology textbook) and gender on Biology students’ interest in genetics.

**Methodology**

The design adopted for this study was non-randomized pretest-posttest control group of the quasi-experimental design with three (3) groups, two (2) experimental groups and a control group. Experimental group one (1) was taught genetics using improvised DNA model resource, experimental group two (2) was taught using realia resource and group three (3) was the

control group taught with Biology textbook resource. The design was considered appropriate since the students were taught in their intact classroom setting. The sample of the study was one hundred and sixty-two (162) Senior Secondary Three (SS3) Biology students (male and female) for 2022/2023 session from three (3) secondary schools in Uyo Municipality of Akwa Ibom State.

Biology Interest Scale in Genetics (BISIG) of 40-items adapted by the researchers was used to ascertain the students’ level of interest in genetics before and after teaching of the concept. A four-point Likert scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) was used. For positive worded items on the BISIG, Strongly Agree (SA) was scored 4 points, Agree (A)- 3 points, Disagree (D)- 2 points and Strongly Disagree (SD) was the lowest with 1 point and the reserve was the case for negative worded items. It was submitted for face and content validation to three (3) lecturers. The instrument was also subjected to Cronbach alpha (A) which had a reliability coefficient of 0.83. Cronbach alpha (A) was used because of the rating scale of four (4) options. The items in the instrument had the same difficulty level and they were non-dichotomously scored.

The Biology teachers were used as research assistants. The research assistants were trained for three (3) days and they were given detailed instructions with well-articulated lesson packages on the concept of genetics. The teachings in all the groups were done during the normal class period for Biology and in intact class setting. This was done in order to avoid disrupting the school programme. The researchers randomly assigned three (3) classes, two (2) experimental groups and a control group respectively. The teaching of the concept was done by the research assistants in each school from a well-articulated lesson package developed by the researchers for two (2) weeks. The lesson packages prepared by the researchers were used in order to standardize the concept taught by the research assistants. Before and after the teaching, pre- and post-interest scale were administered to the three (3) groups respectively. All activities in the three (3) groups were strictly supervised by the researchers. The data collected were analyzed using descriptive statistics (mean and standard deviation), and Analysis of Covariance (ANCOVA) based on its ability to control for the effect of pre-interest. All the hypotheses were tested at .05 level of significance. Hypotheses were rejected when the calculated P value was less than 0.05 set as level of significance, and was not rejected when the calculated P value was greater than 0.05.

**Results**

**Table 1: Mean and Standard Deviation of Pre-Interest and Post-Interest Scores of Students taught Genetics Classified by Instructional Resources.**

Instructional Resources	N	Pre-Interest		Post-Interest		Mean Difference
		$\bar{X}$	SD	$\bar{X}$	SD	
Improvised DNA model	53	13.60	3.72	32.94	5.02	19.34
Realia	65	11.51	2.29	32.48	3.77	20.97
Biology Textbook	44	11.11	2.39	21.18	7.22	10.07

Results in Table 1 show the mean difference scores of students taught the concept of genetics using

improvised DNA model, realia and Biology textbook as 19.34, 20.97 and 10.07 respectively. Comparing the





mean difference scores of the three groups, it indicates that realia with mean difference score of 20.97 was the highest in enhancing students’ interest, followed by improvised DNA model with mean difference score of 19.34. The use of Biology textbook was the least with mean difference score of 10.07 in enhancing students’ interest in genetics.

**Table 2: Summary of Analysis of Covariance (ANCOVA) of Students’ Post-interest Scores Classified by Instructional Resources with Pre-interest Scores as Covariate**

Source of Variance	Sum of Squares	df	Mean Square	F- value	P- value
Corrected Model	4339.498 <sup>a</sup>	6	723.250	25.60	.00*
Intercept	5836.332	1	5836.332	206.61	.00*
Pre-interest	29.800	1	29.800	1.05	.30 <sup>NS</sup>
Resources	3829.587	2	1914.794	67.78	.00*
Gender	52.133	1	52.133	1.84	.17 <sup>NS</sup>
Resources * Gender	5.758	2	2.879	.10	.90 <sup>NS</sup>
Error	4378.385	155	28.248		
Total	150289.000	162			
Corrected Total	8717.883	161			

<sup>NS</sup> = Not significant at .05 level of significance; \* = Significant at .05 level of significance

Results in Table 2 show that the analysis of covariate (pre-interest scores) of the three groups of students taught genetics using improvised DNA model, realia and Biology textbook resources is not significant since the calculated F-value (1.05) having a calculated p-value (.30) is greater than the significant level (.05), indicating that the mean of the three groups were statistically equivalent. The table also shows that the calculated F-value (67.78) having a calculated p-value (.00) of the main effect of resources is less than the significant level (.05), therefore, the null hypothesis one is rejected. This implies that there exists a significant difference among the interest mean scores of Biology students taught genetics using improvised DNA model, realia and those taught with Biology textbook. In order to determine the direction of significance, the scores were subjected to post hoc analysis as shown in Table 3.

**Table 3: LSD (Least Square Difference) Post hoc Analysis of Students’ Post-interest Classified by Instructional Resources with Pre-interest as Covariate**

(I) Resources	(J) Resources	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>
Improvised DNA	Realia	.536	1.11	.63 <sup>NS</sup>
	Biology Textbook	11.703*	1.22	.00*
Realia	Improvised DNA	-.536	1.11	.63 <sup>NS</sup>
	Biology Textbook	11.167*	1.04	.00*
Biology Textbook	Improvised DNA	-11.703*	1.22	.00*
	Realia	-11.167*	1.04	.00*

<sup>NS</sup> = Not significant at .05 level of significance; \* = Significant at .05 level of significance

Table 3 shows the post hoc analysis scores of students taught genetics using improvised DNA model, realia and those taught with Biology textbook resources. Students taught using improvised DNA model and realia resources had a significantly higher interest when compared with those taught using Biology textbook. A non-significant difference existed between the interest of students taught using improvised DNA model and realia.

**Table 4: Mean and Standard Deviation of Male and Female Biology Students’ Pre-interest and Post-interest Scores Taught Genetics Classified by Instructional Resources.**

Resources	Gender	N	Pre-interest		Post-interest		Mean Difference
			$\bar{X}$	SD	$\bar{X}$	SD	
Improvised DNA model	Male	15	15.00	3.83	34.40	4.23	19.40
	Female	38	13.05	3.57	33.37	5.24	20.32
Realia	Male	34	11.18	2.40	32.79	3.17	21.61
	Female	31	11.87	2.15	34.13	4.36	22.26
Biology Textbook	Male	20	10.65	1.75	21.70	7.49	11.05
	Female	24	11.50	2.79	20.75	7.12	9.25

Results in Table 4 show that the mean difference interest score of male students taught genetics using improvised DNA model resource is 19.40 and their female counterparts is 20.32. The mean difference interest score of male students taught genetics using realia is 21.61 and their female counterparts is 22.26. The mean difference interest score of male students taught genetics using Biology textbook is 11.05 and their female counterparts is 9.25. It can be inferred from the results that female students had more interest than their male counterparts when taught genetics using improvised DNA model and realia instructional resources but male students had more

interest than their female counterparts when taught using Biology textbook instructional resource.

Results in Table 2 on the main effects of gender show that the calculated F-value (1.84) having a calculated P-value (.17) is greater than the significant level (.05), therefore, the null hypothesis two is not

rejected. This implies that there exists no significant difference between the interest mean scores of male and female Biology students taught genetics using improvised DNA model, realia and those taught with Biology textbook instructional resources.

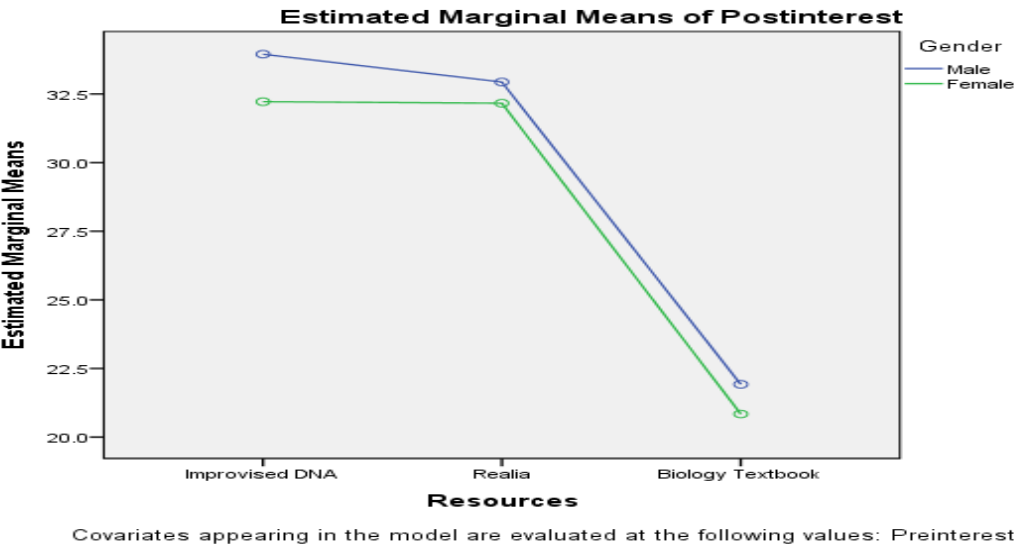
**Table 5: Estimated Marginal Means (Adjusted Means) of Male and Female Students’ Post-interest Scores by Resources using Pre-interest as Covariate**

Gender	Resources								
	Improvised DNA model			Realia			Text Book		
	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Male	15	34.62	4.13	34	32.74	3.37	20	21.61	7.41
Female	38	32.14	5.02	31	32.23	4.25	24	20.96	7.22

Results in Table 5 show that the estimated marginal mean of male students taught genetics using improvised DNA model resource is 34.62 which is higher than the estimated marginal mean 32.74 of male students taught genetics using realia resource, and the estimated marginal mean of female students taught genetics using improvised DNA model resource is 32.14 which is slightly lower than the estimated marginal mean 32.23 of female students taught genetics using realia resource. It can be inferred from the results that the lines of male and female Biology students produced from improvised DNA model to realia resource are not parallel (see Fig. 1), indicating that the lines could result to an interaction between the resources (improvised DNA model, realia) and gender (male, female) in students’ interest in genetics.

Table 5 also shows that the estimated marginal mean of male students taught genetics using realia resource, 32.74 is lower than the estimated marginal mean 21.61 of male students taught genetics using Biology textbook resource, and the estimated marginal mean of female students taught genetics using realia resource is 32.23 which is higher than the estimated marginal mean 20.96 of female students taught genetics using Biology textbook resource. It can be inferred from the results that the lines of male and female Biology students produced from realia to Biology textbook resource shows parallel situation (see Fig. 1), indicating that there is no interaction between the resources (realia, Biology textbook) and gender ( male, female) in students’ interest in genetics.

The interactions are shown in Fig 1.



**Fig 1: Interaction Effect of Instructional Resources and Gender on Biology Students’ Interest in Genetics**

The results of these analyses are presented in Table 2.

Results in Table 2 on the interaction effect of resources and gender show that the calculated F-value (.10) having a calculated p-value (.90) is greater than the significant level (.05), therefore, the null hypothesis three is not rejected. This implies that there exists no significant interaction effect of instructional resources and gender on Biology students’ interest on the concept of genetics. It can be inferred from the result that the interest level of male and female students with regard to the resources are at same levels (See Fig.1) indicating that instructional resources (improvised DNA model, realia, Biology textbook resources) and gender do not

work together to impact on Biology students’ interest on the concept of genetics.

**Discussion of Findings**

The findings on the difference among the mean interest scores of Biology students taught genetics using improvised DNA model, realia and Biology textbook indicated a significant difference. Students taught using improvised DNA model, realia resources had a significantly higher interest when compared with those taught using Biology textbook. A non-significant difference existed among the interest mean scores of Biology students taught using improvised DNA model and realia.

The significantly higher interest of students taught using improvised DNA model, realia resources when compared with those taught using Biology textbook could be attributed to students' direct engagement in the learning process with improvised DNA model, realia resources which the actions are seen in real experiences and could not be possible through the use of Biology textbook. This is why Udoh, and Ekon (2018) asserted that for learning of Biology to be meaningful and effective, the teacher should be able to select appropriate teaching resources that would stimulate the interest of the learners and get them actively engaged in the process of learning since learning is facilitated by involving students in active processing. Onasanya (2023) also added that interest plays an important role in the knowledge of a particular concept in science. This shows that when a learning task is set before the students, the aptness in responding to the said learning task is centrally controlled by interest. The extent to which the student is interested in a particular course of study is indicated by active participation in the study. The finding of this study is in line with that of Edet (2024); Eton and Udoh (2018) who found that students taught Biology concept using instructional resources had a significantly higher interest than those taught the same concept without instructional resource. The findings also collaborate with Effiong (2023) who found that there is a significant difference in the interest of science students when taught with properties of local oils. However, the findings disagree with Breckler, Christensen and Sun (2019) who found no significant difference on students' interest when taught with thermal and electrical conductivity of palm oil in viscosity.

The findings on the difference between the mean interest scores of male and female Biology students taught genetics using improvised DNA model, realia and Biology textbook instructional resources indicated no significant difference. Female students taught using improvised DNA model resources had a significantly higher interest when compared to their male counterparts. A non-significant difference existed between male and female students' interest scores when taught using realia and Biology textbook resources.

The non-significant interest of male and female students might be due to the fact that both male and female students freely interacted and participated in class when taught with the resources which resulted in motivation and sustenance of both and female students' interest in the lesson. This shows that the use of instructional resource could have positive influence in increasing both male and female students' interest in genetics. This confirms why Effiong (2023) stated that students who have interest in study achieved and retained the concept taught better than those with little or no interest. Therefore, student's interest is what every teacher in any field of study strives to obtain in order to transfer learning to the learner. The finding of the study corroborates with Udoh, Umoh, and Udo (2020) who found that female students' interest in biology is significantly better than their male counterparts when taught using technological resources. The finding of the study is also in line with Effiong (2023) who found that female students' interest in physics is significantly better than their male counterparts in physics classes for beginners. The study disagrees with the findings of Anidu and Udoh (2021) who found that interest in male students in science is

significantly better than their female counterparts in science. The study also disagrees with the findings of Amedu (2020) who found that interest during teaching-with-analogy favoured male students over the female students in Biology using jigsaw method.

The findings on the interaction effects of instructional resources (improvised DNA model, realia Biology textbook) and gender on Biology students' interest when taught the concept of genetics indicated no significant interaction effect. This indicates that the instructional resources and gender do not worked together to impact on students' interest. This could be attributed in to the fact that instructional resources provide opportunities for students to ask questions on the concept which tend to affect their interest differently. This is why Kaspar and Borgerding (2017) stated that instructional resources provide an opportunity for students to; clear up any point they have not understood, receive help in solving tricky problems, and have their ideas and understanding challenged by both their peers and tutors. Godspower-Echie and Wisdom (2019) added that the extent to which a student is interested in a particular course of study is indicated by the student's active participation in the study of the subject with resultant good interaction. The finding of the study corroborates with Amedu (2020) that there is no significant interaction effect between methods of teaching and gender on the mean interest scores of experimental and control groups in favour of experimental group. However, the finding of the study is in contrary with Cakir (2017) who showed that there was a significant interaction effect between instructional resources and gender on the interest mean scores of the students taught DNA in genetics using standardized and improvised DNA model instructional resources. The finding of the study is also in disagreement with that of Ajayi and Ogbeba (2017) who found a significant interaction effect between methods and gender on the mean interest scores of students in stoichiometry.

## Recommendations

1. Science teachers, especially the Biology teachers should adopt (improvised DNA model and realia) as instructional resources in teaching various concepts in their classroom interactions. This will make their teaching more effective and meaningful to the students.
2. Parents and Biology teachers should encourage both male and female students towards excellence in Biology since they can benefit equally from science instructions depending on the involvement of an individual student.

## References

- Adewale, A. (2022). Bridging the Educational Resource Gap in Nigerian Schools: Challenges and Opportunities. *African Journal of Education*.
- Ajayi, O. V. and Ogbeba, J. (2017). Interaction effect of gender on secondary chemistry students' interest and achievement in stoichiometry using hands-on activities. *American Journal of Educational Review*, 5(8), 839-842.
- Amedu, O. I. (2020). The interactive effects of gender on interest, academic achievement and retention of students in biology using jigsaw method.

- Journal of Education and Practice*, 6(17), 145-153.
- Anidu, I. C. and Udoh, N. M. (2021). Gender and Perception of Difficult Topics in Secondary School Biology Curriculum among Final Year Biology Education Students of Public Universities in Abia State. *River State University of Education (RSUJOE)*, 24 (2), 37-47.
- Bably, T and Nusrat, D. (2017). The positive effect of realia in EFL classes. *Retrieved from; https://www.researchgate.net/publication/284404050*.
- Breckler, L. J.; Christensen, T., & Sun, W. (2019). High school students' proficiency of thermal and electrical conductivity of palm oil on their interest and performance in viscosity. *Retrieved from: www.ncbi.nlm.nih.gov/pmc/articles/PMC3671653*
- Cakir, M. (2017). Interactive effects of the use of standardized and improvised DNA model instructional resources on students' interest, academic performance and retention of the concept of genetics. *American-Eurasian Journal of Scientific Research*, 11(2), 32-41.
- Edet, C. O. (2024). Relative effects of the use of improvised DNA model and flip chart on students' performance and retention in the concept of genetics in biology. *Masters Dissertation*. University of Uyo, Uyo.
- Effiong, G. I. (2023). Knowledge of thermo-electric properties of local oils as predictor of students' interest, performance and retention in viscosity in physics. *Masters Dissertation, Department of Science Education*, University of Uyo, Uyo.
- Ekon, E. E. and Udoh, N. M. (2021). Effects of Constructivists' Model of Instruction on Students' Perception of their Psychosocial Learning Environment and Achievement in Biology. *Prestige Journal of Counselling Psychology*, 4(1), 1-11
- Etiubon, R. U. and Udoh, N. M. (2017). Effects of practical activities and manual on science students' academic performance on solubility in uruan local education authority of akwa ibom state. *Journal of Education and Practice*, 8(3), 202-209.
- FGN (Federal Government of Nigeria) (2013). *National policy on education*. 5<sup>th</sup> edition. Nigerian educational research and development council, Nigeria. 10p.
- Godspower-Echie, G. and Wisdom, S. (2019). Influence of gender on interest and academic achievement of students in integrated science in Obio akpor local government area of rivers state. *European Scientific Journal*, 13(10), 272-279.
- Kaspar, W, and Borgerding, J. (2017). Peer-reviewed instructional materials online, "primo". *Journal of College and Research Libraries*, (Online), 78: 2-7. Retrieved from: doi:10.5860/crl.78.1.2.
- NPC (2016). National population census in nigeria.
- Okorie, G. N. (2020). Utilization of realia as a teaching resource on the concept of diffusion on academic achievement and retention of biology students' in senior secondary school in Uyo Local Government Area. *Masters Dissertation, Department of Science Education*, University of Uyo, Uyo.
- Onasanya, S. A. (2023). Effect of improvised and standard instructional resource on secondary school students' academic performance in physic in Ilorin, Nigeria. *Singapore Journal of Scientific Research* 1(2), 68-76.
- Sambo, D. D., and Sunday, B. E. (2024). Influence of school environmental factors on students' academic achievement and interest in core science subjects in Uyo Senatorial Districts of Akwa Ibom State, Nigeria. *Global Academic Star Promoter*. Retrieved from <https://globalacademicstar.com>
- Udoh, N. M. and Ekon, E. E. (2018). Influence of Virtual Reality and Flow Chart on Biology Students' Academic Achievement on Circulatory system in Uyo Municipality, Akwa Ibom State, Nigeria. *Journal of Education and Practice*, 9 (2), 123-128.
- Udoh, N. M., Udo, E. E., & Anidu, C. I. (2019). Effects of Acronym and Expression mnemonics on Science Students' Academic Achievement in animal Hormones in Uyo Municipality. *Nigerian Journal of Science and Science Education*, 8 (3), 85-105.
- Udoh, Umoh, and Udo (2020). Effects of Print media and Library Research Teaching Methods on Secondary School Students' Academic Achievement in Biology. *International Journal of Educational Benchmark*, 16 (1), 118-130.