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Effects of Contructivists Approach on Performance and Retention of Genetics Concepts among Secondary School Students in Sokoto State, Nigeria

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Abstract: The study examined the Effects of Constructivists Approach on Performance and Retention of Genetics Concepts among Secondary School Students in Sokoto State, Nigeria. Quasi experimental research design was adopted which involves pre-test, post-test and post-posttest on two non-equivalent groups designated as experimental and control group. Two research objectives and questions guided the study while two null hypotheses were tested at 0.05 level of significant. The population of the study consisted of 1,639 SS II students across the 10 Schools under Science and Technical Education Board in Sokoto State. Multistage sampling techniques was used to select the sample for the study, 237 SS II students were selected from four schools using intact classes. Genetics Performance Test (GPT) instrument which contained 30 items were used to collect data. The instrument was validated by experts in the field of Biology. Pilot testing was used to establish the reliability of (GPT), the reliability coefficient of 0.86 was obtained using (KR-20) formular. The independent t-test was used to test the two null hypotheses. The findings of the study revealed that there is significant difference in the performance and retention of students taught genetics using constructivists approach than those taught using conventional method. Based on the findings, it was recommended among others that, Biology teachers should be encouraged adopt constructivist approach to engage the students in meaningful learning which led to enhanced performance of secondary school students in Genetics.

Keywords: *Constructivist Approach; Genetics Concepts; Students' Performance; Retention; Biology Education; Secondary School Students; Conventional Teaching Method; Quasi-Experimental Design; Genetics Performance Test; Sokoto State.*

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Introduction

Nigeria is one of the developing nations of the world, hence we need better science education to secure a strong foundation for a successful technological society. Since science is an integral part of our daily life, science education is very important for the development of any nation. No doubt, many developed countries were able to achieve so much in science and technology because of the quality of their science education. Teaching science mean a lot, the principal goal of science education is to help students become healthy and creative members of the society with some necessary scientific literacy. To overcome these barriers, teachers need to utilize teaching approaches that will engage the learners in the learning processes. Abdulhamid (2016) reported that teaching approaches affects the responses of students' performance and determined whether they are involved in the teaching and learning processes.

There are many teaching approaches that constitutes teaching and learning of science, but what constitutes a good teaching and learning of science is the use of appropriate means of imparting knowledge so as to ensure that all important concepts are passed on to the learner and not relegated to the background (Ogunkunle & Onwunedo, 2017). For teaching to be effective, (Adunola, 2014) asserts that teachers must be familiar with a variety of teaching approaches that take into account the extent of complexity of the topics to be taught in order to produce desired behavioural changes on the students. For effective teaching, the cognitive level of the learners and their conceptual development which means the extent of prior knowledge about the topic necessary for learning new knowledge should be considered (Okoro & Yaako, 2019). Science teachers, including biology teachers should make use of variety of teaching methods to accomplish lesson objectives. There are many teaching approaches that could be used to teach biology and science in general among which includes; constructivist approach, discussion method, laboratory method, discovery method, to mention but a few. This paper however, focuses on the constructivist approach to teaching of genetics.

Genetics is one of the concepts related to abstraction taught in Biology at Senior Secondary School level in Nigerian schools including Sokoto State. It is the study of gene, heredity and variation in living organisms. Genetics involve heredity and variation which deals with the development of genes and its transmission from generation to generation (Etobro & Banjoko 2017). Whitley *et al.*, (2020) opined that genetic help students to

gain experience in improving plant and animal species in many areas including health, ancestry and traits. Like other sciences, the study of genetics has produced an insight to new challenges as well as solution to human problems. For example, treatment of diseases, plant and animal breeding, applications of genetics in crime detection, establishment of paternity where there is dispute (Umar, Aliyu & Lawal, 2022).

The various teaching approach are into two basic categories: These are teacher-centered and student-centered approaches. The teacher-centered approach is based on the theory of behavioural learning, which emphasizes the importance of providing suitable stimuli that result in the expected and desired outcome in learners (Abell, Appleton, & Hanuscin, 2013). Students become passive to the teachers' instruction rather than actively engaging in the teaching and learning process. Student-centered approaches however, are based on constructivist ideas, which are of the view that students construct meaning of what they do or see by generating links between the existing knowledge and new phenomena to be attended to (Wasagu, 2021).

To learn science from a constructivist approach implies direct experience with science as a process of knowledge generation in which prior knowledge is elaborated and changed on the basis of fresh meaning negotiated with peers and teachers.

Constructivism is a theory that gives hope to the development of the deep understanding of the science concepts. Constructivism is a learning theory which suggests that students will create their own understanding of the material they study by combining information they already knew with newly confronted experiences (Dennick, 2016). The fundamental reason for this method is that it helps learners to gain understanding there-by creating links with previous knowledge.

The use of constructivists approach will help in teaching and learning, because for meaningful learning to occur, new knowledge must be related by the learner's cognitive structure, therefore, the most single factor influencing learning is what the learner already knows (Wasagu, 2021). The retention of the knowledge is also important because it is only when the concepts learned are stored and recalled thereafter that the performance can improve (Yan, 2021; Krishnan, 2021). According to Etsu and Manko (2020) retention is the ability to retain and later recall information or knowledge gained after learning. It is a process in which a long-term memory preserves learning material, so that it is hold, store and recall in the future.

Theoretical Framework

This study is anchored on the theory of cognitive constructivism, pioneered by Jean Piaget (1896-1980), who was widely considered as the father of constructivism. Piaget's theory of cognitive constructivism proposes that humans cannot be given information, which they immediately understand and use; instead, humans must construct their own knowledge. The theory of cognitive development proposes that learners do not gain knowledge from outside, rather they interpret and process new information through the creation of knowledge. They believe that the learners are active participants in the teaching-learning situation and they construct their own knowledge and understanding as they develop mentally. The theory is based on the following assumptions:

i. Individuals actively seek out information from their environment to help them explore.
ii. Individuals build and construct new knowledge based on their experiences and interactions with their immediate world.
iii. Individuals learn through the process of assimilation (dealing with a new event in a way that is consistent with an existing scheme) and accommodation (dealing with new information by modifying existing skills.

One of the main problems facing Nigeria secondary schools is relative decline in academic performance of students especially in Sciences (Enohuen, 2015). Secondary Schools in Sokoto State are not exceptional. Adunola (2014) posits that science students' poor performance is the resultant effect of poor teaching methods employed by the teachers. There is persistent poor performance in science subjects in secondary school certificate examination leading to the assumption that most science teachers in Nigeria secondary schools do not make use of the varied forms of teaching method in teaching and learning of science (Bello, 2014).

The WAEC Chief Examiner's report (2017, 2018, 2019, 2020 & 2023) have consistently lamented the poor performance of candidates in biology for more than two decades, by using phrases like, "not satisfactory, downward trend, abysmal/dismal performance, decline in pass rate, fluctuating performance, and persistent failure," in describing the performance of students in Biology.

There was a similar concern expressed on student performance in biology concepts in Sokoto State, this was evidenced by the reports of the West African Examination Council (WAEC) Chief Examiners from 2017 to 2023. The report indicated that candidates' performance had been on a steady decline. Many authors, academics, and educators have looked into a variety of issues as one or more of the causes of students' poor academic performance in Biology. As reported by the West African Examination Council (WAEC) in 2017, 2018, 2019, 2020, and 2023 displayed by the National Bureau of Statistics (2023),

The public secondary school students from Sokoto State who sat for the final examination and scored 5 credits or above, including Biology, are 38.92%, 34.03%, 50.2%, 43.7% and 39.95%, respectively. The percentage of candidates that obtained five credits and above including Biology from 2017 to 2023 in Sokoto State shows a decline in students' performance in 2018 which is recorded as 34.03%. The performance is not sufficiently acceptable because 61.08%, 65.97%, 49.8%, 56.3% and 60.04% students failed which is considerably large. However, with these outcomes, it is discouraging that none of these years have resulted in a beneficial outcome. Due to the non-participation of Sokoto state public secondary school students in WAEC in 2021 and 2022, the state was excluded from the 2021 and 2022 WAEC reports.

Similarly, the chief examiners of (WAEC, 2023) reported that over the years, senior secondary school candidates result in their biology examinations was quite poor in genetics. Students' weaknesses in Genetics identified by this examination body include; inability to give details in their description of genetic processes in non-sequential order, inability to link structural features with their functions, inability to define test-cross correctly, the poor crossing of generic expressions, students' confusion of basic terms that look and sound alike such as gene and chromosome, allele and alleles, dominant and recessive, genotype and phenotype, meiosis and mitosis, among others (WAEC 2017-2023).

As a result of this, the researcher wants to find out if other teaching methods could be more appropriate in students learning of genetics. Hence the introduction of constructivist approach which rely solely on learner's cognitive structuring (learner centered approach).

Objectives of the Study

The main objective of the study is to:

i. Find out the performance of secondary school students taught genetics using cognitive constructivists teaching approach and those taught using conventional method in Sokoto State.
ii. Determine the retention rate of secondary school students taught genetics using cognitive constructivists teaching approach and those taught using conventional method in Sokoto State.

Research Questions

The following research questions were raised to guide the study.

i. What is the performance of secondary school students taught Genetics using cognitive constructivists teaching approach and those taught using conventional method in Sokoto State?
ii. What is the retention rate of secondary school students taught Genetics using to the cognitive constructivists approach and those taught using conventional method?

Null Hypotheses

The following null hypotheses were tested at 0.05 level of significant.

- HO_1: There is no significant difference in the performance of students exposed to the cognitive constructivists approach and those taught using conventional method in Sokoto State.
- HO_2: There is no significant difference on retention rate of genetics between secondary school students taught using cognitive constructivists approach and those taught using conventional method.

Ahmadu (2019) investigated the effect of constructivists pedagogy on student's performance of senior secondary (SS II) students in transport system biology in of Kogi State. The result of the study revealed that students taught through the constructivist pedagogy performed better than those taught through the conventional method. It was also established that the male students performed better than the female students. Muhammad (2019) carried out research on effect of constructivist instructional strategy on the academic performance of senior secondary school two students' (SS II) of Sokoto State, Nigeria. The following findings were obtained. Students exposed to Constructivism Instructional Strategy performed better than their counter part in Conventional Method. There was significant difference in students' performance between Constructivism and Conventional Method of teaching.

As well, Duyilemi & Bolajoko, (2014) investigated the effects of constructivists' learning strategies on students' achievement and retention in Biology in selected Senior Secondary Schools in Ondo State. The result obtained showed that there were significant main effects of treatment on students' achievement and retention in experimental group.

Methodology

The research design adopted for this study is Quasi-experimental design which involves pre-test, post-test, and post post-test. Quasi experimental design involves the manipulation of one or more independent variables. A quasi-experimental design is often used in classroom experiments and does not involve random assignment of participants into treatment groups, (Best and Kahn 2014).

Constructivist approach of instruction which is students-centered activities was applied to the (Experimental group), while conventional method of instruction was applied to the (control group) during the field work. The design illustrated below:

EG → O1 → X1 → O2 → O3

CG → O1 → X2 → O2 → O3

The population of the study comprises of all science and technical schools that are under the Ministry of Science and Technology in Sokoto State. There are 10 public science and technical schools across Sokoto State with the total number of 1,639 SS II students. The choice of using this population was justified by the fact that, these schools are Purely Science and Technical Schools. Likewise, Biology is one of the science subjects, and genetics concepts is taught from SSI-SSIII. So, the justification for choosing SSII is because they have the basic knowledge about genetics from SSI, and they are not final year students who are busy preparing for external examination.

Multistage sampling techniques was used to select the sample for the study. At stage one: a sample of three (3) education zones were selected from the six (6) Education zones in the state using purposive sampling, the zones are Sokoto North, Sokoto South and Yabo Education zones. However, at stage two: four (4) Senior Secondary Schools were purposively selected as follows: one (1) school each from Sokoto North and Yabo zones while two (2) schools from Sokoto South. At stage three (3): An intact class from each of the four (4) selected schools was selected and two (2) intact classes comprising (one male and one female) were assigned as experimental and control group. However, a sample of 237 SS II Students were selected consisting 115 assigned as experimental group (65 males and 50 females) while 122 assigned to control group (55 males and 67 females).

The research instruments used for data collection are Genetics Performance Test (GPT) was administered as pretest and posttest, while Genetics Retention Test (GRT) was administered as post posttest. The instrument which contains (30) multiple choice items performance test on genetic concepts was administered to an intact class containing 30 Biology students from Government Technical Runjin Sambo Sokoto, for pilot test in order to determine the reliability of the instrument. The reliability of the instrument (GPT) was obtained using Kuder-Richardson formula (KR-20), which exhibited a reliability coefficient of 0.86.

The descriptive statistical tools to be used in describing the demographic data, while mean and standard deviation will be used in answering the research question. Inferential statistic that is, independent T-test will be used in testing the two null hypotheses.

Result and Discussion

Research question one: What is the performance of secondary school students taught Genetics using constructivist teaching approach and those taught using conventional method in Sokoto State?

To answer this question, the posttest performance scores of all the 237 students was collected and sorted according to experimental and control group. The scores were presented in Table 1.

Table 1: Summary of Mean and Standard Deviation of Performance of Students in Genetics between Experimental and Control Group

Group	N	Mean	SD	Mean Diff
Experimental	115	18.09	4.45	
				4.10
Control	122	13.99	4.13	

Source: Field Work, 2024

Table 1 shows the difference in performance of Secondary School Students taught genetics with constructivists approach and those taught using conventional method. The mean scores indicates that students taught with constructivists approach had a mean score of 18.09 and standard deviation of 4.45, while the conventional method group had a mean score of 13.99 and standard deviation of 4.13. their mean difference was 4.10. constructivist approach group achieved higher than conventional method group which means there was difference in performance of students taught genetics with constructivists approach and those taught using discussion method in favour of constructivists approach.

Research Question Two: What is the retention rate of secondary school students taught Genetics using to the constructivists approach and those taught using conventional method?

To answer this question, the post posttest scores of all the 237 students was collected and sorted according to experimental and control group. The scores were presented in Table 2.

Table 2: Summary of Mean and Standard Deviation of Retention Rate of Students in Genetics between Experimental and Control group

Group	N	Mean	SD	Mean Diff.
Experimental	115	14.95	5.32	
				2.23
Control	122	12.72	4.11	

Source: Field Work, 2024

Table 2 presents the data in the difference in retention rate of secondary school students taught genetics using constructivists approach and those taught using conventional method. Results of post- posttest showed that the mean of constructivists approach group had a mean score of 14.95 and standard deviation of 5.32, while the mean of conventional method group is 12.72 and standard deviation of 4.11. their mean difference is 2.23 Constructivists approach group retained more knowledge than conventional method group on post-posttest which means there was difference in students retention taught genetics with constructivists approach than those taught using conventional method.

Testing the Null Hypotheses

- **HO_1:** There is no significant difference in the performance of students exposed to the Constructivists approach and those taught using conventional method in Sokoto State.

Table 3: Summary of t-test Analysis of Students Performance Exposed to Experimental and Control Groups

Group	N	Mean	SD	Df	t-value	P-value	Decision
Experimental	115	18.09	4.45				
				235	7.37	0.00	HO_1
Control	122	13.99	4.13				Rejected

Source: Field Work, 2024

Data on table 3 shows that there was significant difference in the performance of students taught genetics with constructivists approach (Experimental) and those taught using conventional method (Control) with (t=7.37, p=0.00). The difference shows that ($p<\alpha$) level of significance. Those taught using constructivists approach performed better than those taught using conventional method at post-test level. The null hypothesis which stated that

$\alpha<0.05$

there is no significance difference in the performance of students taught genetics with constructivists approach and those taught using conventional method was rejected.

- **HO_2:** There is no significant difference on retention rate of genetics between secondary school students taught using Constructivist approach and those taught using conventional method.

Table 4: Summary of t-test Analysis on Retention of Students Exposed to Experimental and Control Groups

Group	N	Mean	SD	Df	t-value	P-value	Decision
Experimental	115	14.95	5.32				
				235	3.62	0.00	HO_2
Control	122	12.72	4.11				Rejected

Source: Field Work, 2024 $\alpha<0.05$

Table 4 shows that there was significant difference on the post- posttest (retention) of students taught genetics with constructivists approach (Experimental) and those taught using conventional method (Control) with (t=3.62, p=0.00). the p-value (0.00) was less than Alpha value (0.05) level of significance. Those taught using constructivist approach retained more learning than those taught using conventional method at post-posttest level. Therefore, the null hypothesis which stated that there is significant difference in retention of students taught genetics with constructivists approach and those taught using conventional method was rejected.

Discussion

This study investigates the effects of constructivists approach on performance and retention of genetics concepts among secondary school students in Sokoto State, Nigeria. The study came up with the following finding and discussed;

There was significant difference in the performance of students taught genetics using constructivist approach than those taught using conventional method. This result is in line with the finding of studies conducted in Sokoto State, Nigeria by Muhamad, (2019); who reported that constructivists approach has a greater effect on students' academic performance than the conventional method, because the constructivists approach encourages students' active participation and collaborative conversation to construct and reconstruct reasoning and provides them with cognitive development. This is further supported by constructivists theory which affirm to the fact that students learn best when they construct a personal understanding based on experiencing things and reflecting in those experiences. Similarly, Ahmadu, (2019); in North-central part of Nigeria, as investigated upon in transport system, find that there was improvement in the academic performance of students taught using constructivist approach on post-test compared to their colleagues taught using conventional method.

Furthermore, there was significant difference in retention rate of students taught genetics using constructivists approach than those taught using conventional method. This proven that the constructivists approach favors the experimental group than control group. This is in compliance with the study conducted by Duyilemi and Bolajoko, (2014) find that constructivist approach has a positive effect on retention among biology students and there was significant main effect on students' retention in experimental group.

Conclusion

The constructivists approach was efficacious in enhancing students' performance and retention of genetics concepts. It was observed that, during this research learners are actively involved and interactive, which encouraged learners to be responsible and autonomous. It concluded that teaching using constructivists approach, significantly influences students' performance and their ability to retain knowledge over time. The research recommended that in order to improve the students' academic performance and retention, secondary school teachers should be encouraged to adopt constructivist approach which will engage students in a meaningful learning which led to enhance performance of secondary school students.

Recommendations

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

- Biology teachers should be encouraged adopt constructivists approach to engage the students in meaningful learning which lead to enhance performance of secondary school students.
- Biology teachers should be encouraged to incorporate constructivists approach for teaching biology related concepts such as genetics since it enhances retention ability of students.

Limitation of the Study

The limitation of this study is that, the study was limited to some educational zones in the state due to insecurity, which prevented the study from covering a larger area; for this reason, the researcher decided to narrow the study to certain zones.

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