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Effect of Problem Solving Strategy on Students' Interest, Achievement and Retention in Genetics in Doma, Nasarawa State, Nigeria

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Abstract

This study investigated the effect of problem solving strategy on senior secondary school students' interest, achievement and retention in Genetics in Doma, Nasarawa State, Nigeria. Six research questions guided the study and six hypotheses was tested at 0.05 level of significance. The study adopted a pretest-posttest quasi-experimental design with non-equivalent control group. The sample for the study comprised all Senior Secondary III Biology students in Doma, Nasarawa State, Nigeria. Simple random sampling will be used to select four schools in Doma, Nasarawa State, Nigeria. Two instruments namely; Genetics Achievement Test (GAT) and Genetics Interest Rating Scale (GIRS) were used for data collection. The data collected from the trial testing of the instruments was used to calculate the instruments' reliability coefficient using Kuder – Richardson ($K - R_{20}$) and Cronbach Alpha coefficient methods respectively. Consequent to this, the Kuder – Richardson reliability coefficient obtained for Genetics Achievement Test scores was 0.96; while Cronbach's Alpha reliability coefficient obtained for Genetics Interest Rating Scale scores was 0.80. The data collected were analyzed using mean and standard deviations was used

to answer the research questions and Analysis of Co-variance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The findings of this study revealed the following; There was a significant difference in the mean interest ratings of students taught Genetics using Problem Solving Strategy and the conventional method ($F = 67.428$; $p = 0.000 < \alpha = 0.05$). There was a significant difference in the mean achievement scores of students taught Genetics using Problem Solving Strategy and the conventional method ($F = 12.079$; $p = 0.001 < \alpha = 0.05$). There was no significant difference in the mean retention scores of students taught Genetics using Problem Solving Strategy and the conventional method ($F = 2.155$; $p = 0.145 > \alpha = 0.05$). Based on the findings of this study, it was recommended that; Adoption of problem solving strategy by the biology teachers would go a long way in improving students' interest, achievement and retention in genetics.

Keywords: Achievement, Genetics, Interest, Retention and Problem Solving Strategy

Introduction

Genetics is the study of heredity and variation in living organisms. The passing on and expression of traits or characters from parents to offspring is termed heredity or inheritance. Heredity or inheritance may give rise to differences among individual organisms, this is term hereditary variations (Samuel & Oka, 2020; Nworgu, 2012). The genetical knowledge acquired by man enables him to embark on series of technologies for his utilization such as the selection of different strains of plants or animal species for the purpose of cross breeding to improve the structure, function, or yield of organism for economic importance to human life. The knowledge has enabled geneticists to determine blood groups paternity there by leading to counselling of patient, finger prints detection often used in crime detection, production of test tube babies, rhesus factors in sex determination, drugs and medical

preparations obtained from animal tissues and other organic sources for human utilization (Samuel & Abba, 2020). It has also enabled geneticists to discover diabetes, sickle cell anemia, human DNA, blood group of individual donors and recipients using genetics crossing and agglutination or blood transfusion in human beings (Mader & Windelspecht, 2016).

In genetics, students learn certain aspects of genes and their mode of transmission from generation to generation. Such knowledge should help students to understand problems of genetic nature rather than relying on superstition and other mystical explanations. Students also learn accurate scientific ways of explaining the genetic defects that may be found in their families and communities (Balogun, 2011). The teaching of science in general and biology in particular in school enable students to acquire broad knowledge, skills and attitudes that would equip them to solve their personal and societal problems as they develop into adults. Thus the business of school is to guide youngsters to develop competencies for problem solving in the environment. The different subjects which they are taught in the school are intended to equip them with different kinds of knowledge, skills and dispositions for problem recognition, identification and solving within the environment. The problems of teaching genetics are mainly due to the conventional teaching method that is used by numerous secondary school Biology teachers. Many researchers are of the opinion that lecture method promotes rote learning and memorization (Nworgu, 2012).

Despite the emphasis on innovative approaches to the teaching of science in general and Biology in particular for acquisition of science process and problem-solving skills, Biology is still taught by traditional methods. The poor methods of teaching and learning of Biology seem to constitute a problem in the learner's acquisition of functional knowledge, science process skills and development of ability to solve problem (Staver, 2014). In solving this problem, educators seek more reliable and effective methods of instruction for students, so as to produce in learners' skills that will enable them to compete successfully in technological and scientific dominated society. In describing a new vision for teacher educator, Long (2011) suggested that teachers will need to be flexible,

dynamic, thoughtful and able to work with change. He further suggested that the competence of teachers will be the ability to reflect on teaching methods so as to meet the needs of their students. These innovative methods have not been employed when compared with the traditional method that is constantly employed by science teachers in Nigeria (Okoro, 2011).

Problem-solving competencies are the knowledge and general disposition or attitudes which individuals need to be able to identify and tackle observed or perceived problems in the environment with a view to finding solution to them (Staver, 2014). An individual with the requisite knowledge, skills and disposition to identify and solve a problem is said to be competent in that area of socio-economic life (Festus & Epkete, 2012; Gamze, Serap & Mustapha, 2011). A number of problem-solving models have been proposed in learning of different aspect of science. Such include Mettes, pilot and Rossink (1981), Salvaratman and Frazer (1982), Polya (1957) and Systematic approach to problem solving (SAP), to mention a few. The present study used the Polya four (4) steps of problem solving model due to its relevance to the problem at hand.

Interest is considered to be the feeling of an individual towards a particular object or an activity. It means that a child will develop interest in any object or activity that is found to be attractive or stimulating. Therefore, in a classroom situation, the learner will be attentive during a lesson only if the instruction is appealing to the learner (Okoro, 2011). Students interest is paramount in the learning of Biology. It is an indispensable element in learning. For meaningful learning to occur in Biology, the learner must be interested in the subject's contents, this will motivate them to comprehend concepts taught and achieve better.

Achievement is used synonymously with success. It is something that somebody has succeeded in doing usually with effort. Achievement is an important educational variable that expresses the success and failure of a teaching and learning process. Hence achievement refers to the degree of success reached or attained by an individual (Enyi, 2014). According to Eze (2010), achievement could be referred to as something very good or difficult

which was carried out successfully. Ajah (2004) regarded achievement as a change in behaviours exhibited at the end of a given period of time or within a given range of time.

Retention is the ability to retain the teaching and learning experiences as specifically a preservation of the after effects of such experiences and learning that makes recall or recognition possible through remembering of what has previously been learnt, understood and stored in the memory. The positive retention ability enhances recall of learnt facts for problem solving in applying genetical skills' concepts. Staver (2014) and Mader and Windelspecht (2016) observed that students' achievement in genetics and mathematics respectively become poorer as the test items moved from those requiring ability to recall to those involving some understanding and problem solving.

Statement of the Problem

The emerging concern in the poor achievement of students in genetics and its resultant consequence on the production and development of future scientists, engineers and technologies had led to the search for instructional strategies that promote effective and improved science learning. The implication of the students' poor achievement in genetics is that, Nigeria would hardly become a genetically engineered Nation like other Nations of the world. As a matter of fact, the country may lack geneticist manpower to man geneticist centres in the Faculties of biological sciences or Faculties of life sciences as the case may be in some Universities and Faculties of Medical Sciences. Medical institutions like public specialist Hospitals, General Hospitals, specialized Bio-Medical public and private laboratories and private hospitals leaving quarks to practice in the fields of medicine thereby exposing many human lives to danger or early termination of their lives. The need to redress this alarming academic problem necessitated exploring the effect of problem solving strategy on students' interest, achievement and retention in genetics. The problem of this study therefore is, what is the effect of problem solving strategy on senior secondary

school students' interest, achievement and retention in genetics in Doma, Nasarawa State, Nigeria?

Literature Review

Ntibi and Neji (2018) investigated the effect of problem solving approach on students' academic performance. Results of findings revealed that the experimental groups taught with guided problem-solving approach had a higher mean score than the control group taught with conventional method. Ishaku (2015) investigated the effects of problem-solving and discussion teaching methods on students' achievement across ability levels in genetics. The findings revealed that students taught using problem solving strategy achieved higher than those taught using the discussion method. Garba (2015) investigated the use of problems-solving and its effect on student achievement. The results revealed that student taught using problem-solving performed significantly better than those taught through lecture method. Festus and Ekpete (2012) investigated the influence of problem-solving techniques on students' performance and attitude. The results revealed that student taught using problem-solving achieved significantly better than those taught through conventional method. Bawa (2011) investigated the effects of Problem Solving Instructional Strategy on Academic Achievement and Retention. The findings from the study revealed that student taught using problem-solving achieved and retained significantly better than those taught through conventional method. This sought to establish the effect of problem solving strategy on senior secondary school students' interest, achievement and retention in genetics in Doma, Nasarawa State, Nigeria.

The theory of learning related to this study is Gestalt theory of problem solving. According to the Gestalt Theory, which is commonly known as the Law of Simplicity, every stimulus is perceived by humans in its "simplest form". The main focus of the theory is "grouping" and the entire theory emphasizes on the fact that the whole of anything is greater than the sum of its parts. The primary goal of the Gestalt Theory is to encourage the brain to view not just the whole,

but also the parts that make up that whole. Gestalt psychologists, (Duncker 1945) and Wertheimer (1959) offered several ways of conceptualizing what happens during insight. According to them, insight involves building a schema in which all the parts fit together and suddenly reorganizing the visual information so that it fits together to solve the problem. Insight involves restating a problem goal in a new way that makes the problem easier to solve and removing mental blocks. It also involves finding a problem analogue (i.e. similar problem that the problem solver already knows how to solve). This model of the insight theory of learning is relevant to this study, because the learners will be exposed to learning environment with varieties of activities for both hands on and minds on, which made the learning to be learners' centred and thus the learners' use the experience to have insight and understanding of problem situations will help them reorganize visual information about such situation and consequently solve the problem. However, this current research is to investigate the effect of problem solving strategy on senior secondary students' interest, achievement and retention in genetics where by the students used as the target population will be exposed to learning situation with problem solving strategy in a varieties of lessons using hands on and minds on activities in solving problems based on their understanding.

Research Questions

The following research questions guided the study:

1. What are the mean interest ratings of biology students taught Genetics using problem solving strategy and those taught using conventional teaching method?
2. What are the mean achievement scores of biology students taught Genetics using problem solving strategy and those taught using conventional teaching method?
3. What are the mean retention scores of biology students taught Genetics using problem solving strategy and those taught using conventional teaching method?

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

Ho_1. There is no significant difference in the mean interest ratings of biology students taught Genetics using problem solving strategy and those taught using conventional method of teaching.

Ho_2. There is no significant difference in the mean achievement scores of biology students taught Genetics using problem solving strategy and those taught using conventional method of teaching.

Ho_3. There is no significant difference in the mean retention scores of biology students taught Genetics using problem solving strategy and those taught using conventional method of teaching.

Methodology

The study adopted a pretest-posttest quasi-experimental design with non-equivalent control group. The population for this study comprised 1514 SS III Biology students in the twenty-three public coeducational senior secondary schools in Doma Area Inspectorate office which comprises 859 males and 655 females of the 2019/2020 academic session. The sample for this study was made up of 103 (61 Males and 42 Females) students. Two co-educational schools were drawn from twenty-three schools in the area using simple random sampling technique. From the two schools selected, one was assigned as the experimental groups and the second school was assigned as the control group randomly assigned by toss of the coin. The head was assigned to the experimental group (N= 48), while the tail was assigned to the control group (N=55). Two instruments namely; Genetics Achievement Test (GAT) and Genetics Interest Rating Scale (GIRS) were used for data collection. The data collected from the trial testing of the instruments was used to calculate the instruments' reliability coefficient using Kuder – Richardson ($K - R_{20}$) and Cronbach Alpha coefficient methods respectively. Consequent to this, the Kuder – Richardson reliability coefficient obtained for Genetics Achievement Test scores was 0.96; while Cronbach's Alpha reliability coefficient obtained for Genetics Interest Rating Scale scores was 0.80.

Data Analysis and Results

The data collected were analyzed using mean and standard deviations was used to answer the research questions and Analysis of Co-variance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Research Question One

What are the mean interest ratings of biology students taught Genetics using problem solving strategy and those taught using conventional teaching method?

Table 1: Mean Interest Ratings and Standard Deviations of Students taught Genetics using Problem Solving Strategy and the Conventional Method

Methods		PreInterest	PostInterest
	Mean	52.60	63.94
PSS	N	48	48
	Std. Deviation	5.085	6.166
	Mean	51.05	54.45
CM	N	55	55
	Std. Deviation	5.310	5.446

Table 1 reveals that for the students taught Genetics using Problem Solving Strategy, mean interest ratings for the pre-interest is 52.60 and for the post-interest is 63.94. Those taught using the Conventional Method, the mean interest ratings for the pre-interest is 51.05 and for the post-interest is 54.45.

Hypothesis One

There is no significant difference in the mean interest scores of biology students taught Genetics using problem solving strategy and those taught using conventional method of teaching.

The data to test this hypothesis is presented in Table 4.2

Table 2: Result of ANCOVA of Students taught Genetics using Problem Solving Strategy and the Conventional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2797.536[a]	2	1398.768	48.303	.000
Intercept	1397.715	1	1397.715	48.267	.000
PreInterest	492.625	1	492.625	17.012	.000
Methods	1952.587	1	1952.587	67.428	.000
Error	2895.824	100	28.958		
Total	362704.000	103			
Corrected Total	5693.359	102			

Table 2 reveals a significant difference in the mean interest ratings of students taught Genetics using Problem Solving Strategy and the conventional method. F = ratio of 67.428 was obtained with associated exact probability value of 0.000. Since the associated probability (0.000) is less than 0.05 set as level of significance, the null hypothesis was rejected. This indicates that there was a significant difference in the mean interest ratings of students taught Genetics using Problem Solving Strategy and the conventional method.

Research Question Two

What are the mean achievement scores of biology students taught Genetics using problem solving strategy and those taught using conventional teaching method?

Table 3: Mean Scores and Standard Deviations of Students taught Genetics using Problem Solving Strategy and the Conventional Method

Methods		**Pretest**	**Posttest**
PSS	Mean	20.17	25.08
	N	48	48
	Std. Deviation	5.171	6.418

CM	Mean	21.31	23.18
	N	55	55
	Std. Deviation	5.470	5.929

Table 3 shows that for the students taught Genetics using Problem Solving Strategy, mean achievement scores for the pre-post is 20.17 and for the post-test is 25.08 and for the students taught Genetics using conventional method, the mean achievement scores for the pre-test is 21.31 and for the post-test is 23.18.

Hypothesis Two

There is no significant difference in the mean achievement scores of biology students taught Genetics using problem solving strategy and those taught using conventional method of teaching.

The data to test this hypothesis is presented in Table 4.

Table 4: Result of ANCOVA of Students taught Genetics using Problem Solving Strategy and the Conventional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2189.626[a]	2	1094.813	63.033	.000
Intercept	257.948	1	257.948	14.851	.000
Pretest	2096.950	1	2096.950	120.730	.000
Methods	209.800	1	209.800	12.079	.001
Error	1736.898	100	17.369		
Total	63591.000	103			
Corrected Total	3926.524	102			

Table 4 reveals a significant difference in the mean achievement scores of students taught Genetics using Problem Solving Strategy and the conventional method. F = ratio of 12.079 was obtained with associated exact probability

value of 0.001. Since the associated probability (0.001) is less than 0.05 set as level of significance, the null hypothesis was rejected. This indicates that there was a significant difference in the mean achievement scores of students taught Genetics using Problem Solving Strategy and the conventional method.

Research Question Three

What are the mean retention scores of biology students taught Genetics using problem solving strategy and those taught using conventional teaching method?

Table 5: Mean Scores and Standard Deviations of Students taught Genetics using Problem Solving Strategy and the Conventional Method

Methods		Posttest	Retention
	Mean	25.08	25.02
PSS	N	48	48
	Std. Deviation	6.418	6.323
	Mean	23.18	22.44
CM	N	55	55
	Std. Deviation	5.929	5.827

Table 5 shows that for the students taught Genetics using Problem Solving Strategy, mean retention scores for the post-test is 25.08 and for the retention is 25.02 and for the students taught Genetics using Problem Solving Strategy, the mean retention scores for the post-test is 23.18 and for the retention is 22.44.

Hypothesis Three

There is no significant difference in the mean retention scores of biology students taught Genetics using problem solving strategy and those taught using conventional method of teaching.

The data to test this hypothesis is presented in Table 6.

Table 6: Result of ANCOVA of Students taught Genetics using Problem Solving Strategy and the Conventional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2305.549[a]	2	1152.775	73.046	.000
Intercept	202.571	1	202.571	12.836	.001
Posttest	2134.347	1	2134.347	135.243	.000
Methods	34.006	1	34.006	2.155	.145
Error	1578.159	100	15.782		
Total	61449.000	103			
Corrected Total	3883.709	102			

Table 6 reveals no significant difference in the mean retention scores of students taught Genetics using Problem Solving Strategy and the conventional method. F = ratio of 2.155 was obtained with associated exact probability value of 0.145. Since the associated probability (0.145) is greater than 0.05 set as level of significance, the null hypothesis was not rejected. This indicates that there was no significant difference in the mean retention scores of students taught Genetics using Problem Solving Strategy and the conventional method.

Discussions of Findings

The findings of this study reveal that there was a significant difference in the mean interest ratings of students taught Genetics using Problem Solving Strategy and the conventional method. This is agreement with findings of Festus and Ekpete (2012) who found out that the attitude of students if positive can help enhance their interest in the study of Genetics. Also, there was no significant difference in the mean interest ratings of male and female students taught Genetics using Problem Solving Strategy. The findings of this study revealed that there was a significant difference in the mean achievement scores of students taught Genetics using Problem Solving Strategy and the conventional method. This is agreement with findings of Ntibi and Neji (2018),

Ishaku (2015) and Garba (2015) who in their different researches reported that the use of Problem Solving Strategy in teaching and learning of genetics and other scientific concepts has significant effect on the students. The findings of this study also revealed that there was a significant difference in the mean retention scores of students taught Genetics using Problem Solving Strategy and the conventional method. This concurs with the findings of Adebola and Sikiru (2012) and Bawa (2011) who in their different researches found out that students retain Genetics and other Science related concept better when exposed to Problem Solving Strategy.

Conclusion

The findings of this study have shown that Problem Solving Strategy is more effective than the Conventional Method. Also, the findings revealed that the interest of students in the Problem Solving Strategy group was higher than the Conventional Method group. The findings of this study served as a basis for making the following conclusions: problem-solving strategy of teaching enhanced students' interest, achievement and retention in Genetics Problem-solving strategy fosters these students learning outcomes by engaging students actively in solving problems and becoming aware of every phases in complex process. The results of the study also indicated that students could be better problem-solvers if they are of high interest level. Adoption of problem solving strategy by the biology teachers would go a long way in improving students' interest, achievement and retention in genetics.

Recommendations

Based on the findings of this study, it was recommended that:

1. Biology teachers should be encouraged to develop and adopt Problem solving instructional strategy in teaching and learning of genetics because it will motivate the learners and develop their spirit of exploration and discovery.
2. Seminars and in-service programs should be organized by delegations of education and the pedagogic offices for biology teachers in the field to

be acquainted with teaching of genetics using problem-solving and discussion teaching methods.

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