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Effect of Problem-solving Strategy on Students' Academic Performance in Genetic Concepts in Biology in Senior Secondary Schools in Kogistage, Nigeria

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Abstract

This study determined the effect of problem-solving strategies on students' academic performance in genetic concepts in Biology. The study adopted the pretest-posttest control group, a quasi-experimental design. 80 SSII Biology students from two (2) co-educational schools in Idah Local Government Areas of Kogi State were randomly assigned to the treatment group. The instruments used were the Biology Student Performance Test (r=0.78) and Teachers' Instructional guides on problem-solving strategy. Two Research Questions and hypotheses guided the study. Descriptive statistics of means and standard deviation were used to answer the research questions and inferential statistics of Analysis of Covariance was used to test the hypotheses at 0.05 level of significance. The results of the study showed that the problem-solving strategy enhanced students' academic performance in genetic concepts in biology rather than the lecture method. There is a significant difference between the academic performance mean score of the students exposed to genetic concepts using problem-solving strategy in biology and compared with their counterparts taught using the lecture method. There was no significant difference between the mean academic performance scores of male and female students exposed to genetic concepts using problem-solving strategy in biology and compared with their counterparts taught using lecture strategy. Based on the findings, biology teachers should adopt a problem-solving strategy to teach biology students, so that they can learn faster and better as it could foster confidence in the students and improve their academic performance.

***Keywords*:** Problem-solving strategy, academic performance in biology, gender, and genetic concepts.

1. Introduction

Biology is an indispensable tool in the study of sciences, humanities, and technology. Its usefulness to man activities cannot be underestimated. Okagbare (2022) defines biology as a branch of science that involves the study of living things. Ramalingam (2015) defined biology as a branch of science that deals with the study of living things.

Biological ideas have helped to make possible the revolution in electronics which has transformed the way we think and live today. This is why Biology education occupies a proud place in all levels of education. Biology forms the basis of disciplines like human medicine, veterinary medicine, Nursing, Agriculture, forestry, fishery, pharmacy, food technology, laboratory science Technology, biological weapons, and human nutrition to mention just a few. Effective teaching of biology is essential in order to enhance student's performance in the subject.

Biology is one of the science subjects that secondary school students offer at the senior levels in Nigerian secondary schools, (Federal Republic of Nigeria (FRN), 2014). The objectives of the biology curriculum at the secondary school level are to; prepare students to acquire adequate laboratory and field skills in biology, prepare students to acquire meaningful and relevant knowledge in biology prepare students to acquire the ability to apply scientific knowledge to everyday life in matters of personal and community health and agriculture and prepare students to acquire reasonable and functional scientific attitudes (Federal Republic of Nigeria (FRN), 2014). The subject has opened many career opportunities for students in medicine, pharmacy, nursing, veterinary science, food technology, and agriculture among others. Apart from career opportunities from biological studies, the subject has also contributed in areas relating to livestock raising through cross-breeding of various varieties of plant and animal species, development of vaccines and drugs for preventing and curing diseases, increase in food production, and awareness of genetic diseases (Ramalingam, 2015).

The poor and inconsistent performance of biology students in public examinations conducted by WAEC, NECO, and NABTEB has been persistent over the years. Chief examiner reports (WAEC, 2020, 2022, 2023, and 2024) showed that the performance of students in the SSCE biology is on the decline. Available statistics from WAEC and NECO on senior secondary students' performance in biology revealed very poor results in biology. Yusuf and Afolabi (2020) attributed that poor performance is caused by poor teaching methods, and faulty instructional strategies among others. In this vain, therefore, it was meaningful to innovate newer strategies leading to better performance and understanding of the subject (Ibok, 2015).

Hence researchers such as Adewumi and Adeoye (2023), Ibitoye (2021), and Ogundiwin (2013) suggested the use of active learning strategies. Among the strategies that have been explored in previous research are the active review strategy by Ogundiwin, et al (2024) mind mapping by Adewumi (2021), Experiential strategy by Awolere (2015), Flipped Classroom strategy by Adewumi, et al (2024) and Critical exploration strategy by Oloyede (2014). In spite of all these strategies, students still experienced a high rate of poor and inconsistent performance in the subject especially, in the senior secondary school certificate examinations conducted by the West Africa Examination Council (WAEC), National Business and Technical Examination Board (NABTEB) and National Examination Council (NECO). The problem of poor performance in Biology is a great concern to Biology educators and relevant stake-holders in education. Most secondary school teachers appear to use the lecture method to teach biology which does not to help the students understand the various scientific concepts and this hinders the development of their analytical reasoning. As a result of poor strategies of teaching; most students feels that the subject is too difficult and esoteric to understand.

One of the active instructional strategies that caught the attention of researchers is the Problem-solving strategy. Problem-solving strategy is a systematic approach that reviews learning competencies, comprehending and composing, critical and creative thinking, and these features are the most important dimen-

sions of thinking and learning regardless of the acknowledgment of the importance of developing Problem-Solving skills. However, Engle (2017) opined that the problem is the organization of teaching situation in such a way that the students are confronted with what they have to solve in the subject with a certain amount of help. In the Problem-Solving strategy, the role of the teacher is to describe to the students the terminal performance that constitutes the solution to the problem. Assess the students' entering behavior for the concept and principles they will need to solve the problem. As a teaching strategy, problem-solving entails training the students on how to solve problems by proceeding in a logical step-by-step manner from a problem state to its solution. It is on this premise that theorists in problem-solving have identified basic stages involved in the strategy (Smith, 2018). According to Lorenzo (2015), students using problem-solving methods were more confident and had a higher ability to solve difficult problems.

In the course of concentrating on the biology students' performance gender usually suffice. Gender refers to the classification of human beings on the basis of sex due to the roles they perform. Gender has also remained an important issue that is relevant to the field of education because it has been linked with students' performance. According to Awodun (2015), gender differences have become critical issues of concern around the world most especially to educators and researchers. Most studies show that on average girls do better in school than boys (Adewumi, 2014). The study of Yuniskurin, Noviyanti, Mukti, Mahana, and Zubidah (2019) also shows that female are better at spelling and perform better on tests of literacy, writing, and general knowledge in education. In contrast, Okafor (2021) and Ekon and Eni (2015) showed that women were not only under-represented but their levels of performance in the fields of sciences and technology were low compared to their male counterparts.

Many research studies have used different instructional strategies for the teaching and learning of biology in senior secondary schools. However, not much has been done using problem-solving strategy of teaching and gender together in the area of teaching and learning of genetics concepts in biology in the senior secondary schools in Idah local government of Kogi State, Nigeria. It is this gap that this research work stands to fill. This research work seeks to find out the effect of problem–solving strategy on students' academic performance in genetic concepts in biology. The moderating effect of gender was investigated.

2. Statement of the Problem

The problem of poor and inconsistent student performance in Biology is a great concern to Biology educators and relevant stakeholders in education in Kogi State. The performance of Biology students in the Senior School Certificate Examination (SSCE) in the West African Examination Council (WAEC) and National Examination Council (NECO) has not encouraging in recent years (Chief Examiner Report 2020, 2021, 2022 2023 and 2024). Most secondary school instructors appear to use lecture methods to teach Biology which results in students not being able to explore the natural environment and; the inability of the students to see, feel, and touch science resources that will bring about creative thinking and learning of science in their natural state. Students'This poor performance in biology may be attributed to teachers' lack of use of appropriate methods of teaching. On this basis, this study investigated the effect of problem-solving methods on Biology student's academic performance in senior secondary schools in Idah Local Government Area of Kogi State.

3. Purpose of the Study

The purpose of this study was to investigate the effect of problem-solving strategy on students' performance in genetics concepts in Biology in Kogi State. Specifically, the study sought to;

1. Determine the difference in the mean performance scores of students taught genetic concepts in biology using problem-solving strategy and those taught using lecture method.
2. Determine the difference in the mean performance scores of male and female students taught genetic concepts in biology using a problem-solving strategy.

4. Research Hypotheses

To guide the study two null hypotheses were formulated and were tested at a 0.05 level of significance: The following research questions were raised to guide the study:

1. What are the mean performance scores of students taught biology using problem-solving strategy and those taught with lecture method?
2. What are the mean performance scores of male and female students when taught biology using problem-solving strategy and those taught with lecture method?

5. Research Hypotheses

The following research hypotheses were formulated to guide the study and were tested at a 0.05 level of significance:

1. There is no significant difference in the mean performance scores of students exposed to genetics concepts in biology using problem-solving strategy and their counterparts taught using lecture method
2. There is no significant difference between the mean performance scores of male and female students when exposed to problem-solving strategy and their counterparts taught using the lecture method

6. Methodology

This study adopted the pretest-posttest control group quasi-experimental research design. The study involved two groups: an experimental and a control group which was drawn from the population of the senior secondary class two (SSII) in Idah Local Government Area of Kogi State. The experimental group was taught genetics using a problem-solving strategy while the control group was taught genetics using the lecture method. The population of the study consists of 870 senior secondary school year two students in public senior secondary schools in the study area. The sample of the study was made up of eighty (80) SSII students comprising 36 males and 44 females. A simple random sampling technique was used to select the sample for the study. Two (2) schools were selected in Idah Local Government Area, Kogi State. Therefore, one (1) intact class was selected from each of these schools. The two schools with their intact class were sorted and randomly assigned to two groups that were experimental and control groups respectively. The experimental group was exposed to the problem–solving strategy while the control group was to the lecture method.

The instrument used for the study was the Biology Students Performance Test (BSPT) which was constructed by the researcher. The instrument consists of two sections: Section A and B, Section A was for students' bio-data information while Section B consisted of twenty (20) items, and four (4) option multiple choice tests. The instrument was validated by one secondary school biology teacher who is a seasonal WAEC/NECO examiner and two (2) University lecturers one (1) from the department of Science Education and one from the department of Test and measurement. The pretest and posttest marking

schemes, as well as the lesson notes for the both experimental and control groups, were developed by the researcher and were examined for face validity and appropriateness for the two groups. The Biology Student Performance Test instrument (BSPT) was pilot–tested to establish its reliability. A reliability index of r = 0.78 was obtained.

The biology student performance test (BSPT) was administered to both students in the experimental and control groups. The data collected were subjected to both descriptive and inferential statistics. The treatment lasted for six weeks. The research questions were answered with the use of means and standard deviation while research hypotheses were tested using inferential statistics and analysis of Covariance (ANCOVA) at 0.05 level of significance.

7. Results

Research Question 1: What are the mean performance scores of students taught biology using problem-solving strategy and those taught with lecture method?

Table 1 *Descriptive Statistics of Performance Associated with Treatment*

Treatment	N	Mean scores Pre-test		Mean scores Post-test		Means
		X1	SD1	X2	SD2	Gain
Problem-solving strategy	39	23.01	1.63	42.23	1.23	+19.22
Lecture method	46	19.32	1.90	24.65	1.98	+5.33
Mean Difference		3.69		17.58		+13.89

Table 1. shows that the pre-test and post-test mean scores of students taught with the Problem-Solving strategy(experimental group) were 23.01 and 42.23 with a standard deviation of 1.63 and 1.23 respectively. The pre-test and post-test mean scores of students taught with the lecture method were 19.32 and 24.65 with standard deviations of 1.90 and 1.98 respectively. From the above analysis, there is a mean gain of 19.22 for the experimental group and 5.33 for the control group. The experimental group has a mean gain difference of 13.89 from the control group. This indicated that students taught biology using problem-solving strategy performed better in genetics concepts in biology than their counterparts taught with the lecture method.

Research Question 2: What are the mean performance scores of male and female students when taught biology using problem-solving method and those taught with the lecture method?

Table 2 *Descriptive Statistics of Performance Associated with Gender*

Treatment	N	Mean scores Pre-test		Mean scores Post-test		Means
		X1	SD1	X2	SD2	Gain
Male	37	21.33	1.53	43.44	0.87	+22.11

Treatment	N	Mean scores Pre-test		Mean scores Post-test		Means
		X1	SD1	X2	SD2	Gain
Female	48	22.82	1.78	39.88	0.59	+17.06
Mean Difference		1.49		3.56		+5.05

Table 2: shows the pre-test and post-test mean scores of male and female students taught using Problem problem-solving strategy (experimental group). From the analysis, the pre-test and post-test scores of male students were 21.33 and 43.44 with standard deviations of 1.53 and 0.87 respectively. The pre-test and post-test mean score of female students was is 22.82 and 39.82 with standard deviation of 1.78 and 0.59 respectively. From the above analysis, there is a mean gain of 22.11 for the male students and 17.06 for the female students. The male has a mean gain difference of +5.05 over the female.

H_{01}: There is no significant difference between the mean achievement score of students taught genetic concepts in biology using Problem Solving and compared with their counterparts taught with the lecture method.

Table 3 *Analysis of Covariance (ANCOVA) of Post-Performance by Treatment and Gender*

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4566.237	2	1614.	19.645	0.001	0.209
Intercept	2576.759	1	2576.759	308.312	0.000	0.353
Pre-Test	2079.363	1	2079.363	24.881	0.003	0.008
Treatment	2110.624	1	2110.624	49.060	0.001*	0.095
Gender	53.919	2	26.960	0.925	0.397	0.006
Error	97231.200	74	29.135			
Total	11311.000	78				
Corrected Total	12298.820	76				

*denotes signification <0.05

The analysis of data in Table 3 shows that the value associated with the calculated value of F (49.060) for the effect of problem-solving method on the academic performance of students in genetic concepts in biology is 0.001. Since this value (0.001) is less than the 0.05 level of significance. Thus, null hypothesis is thereby rejected and the alternative hypothesis is accepted; which means that there is a significant difference between the post-test scores of the students exposed to genetic concepts in biology using Problem Solving and compared with their counterparts taught with the lecture method.

H_{02}: There is no significant difference between the mean achievement score of male and female students taught genetic concepts in biology using the Problem-Solving strategy and compared with their counterparts taught with the lecture method.

The analysis in Table 3 shows that the value associated with the calculated value of F (0.925) for the effect of gender on students' academic performance in genetic concepts in biology is 0.397. Since this value of 0.397 is greater than the 0.05 level of significance, the null hypothesis was accepted. Thus, there

is no significant difference between the mean performance score of male and female students exposed to genetic concepts in biology using Problem Solving and compared with their counterparts taught with the lecture method.

8. Discussion of the Findings

Evidence obtained from Table 3 of this study shows that the problem-solving method has a significant effect on students' academic performance in biology. The students exposed to genetic concepts in biology using problem-solving methods performed better than those taught with lecture methods. This result is not surprising because problem-solving strategy involves a systematic approach in guiding students through the process of identifying problems, analyzing the problem, generating solutions to the problem, evaluating solution, and implementing the solution. The problem-solving strategy encourages learners to explore the content through the use of concrete experiences to comprehend genetic concepts easily. The result of the findings is in line with Margaret (2022) and Nneka (2019) discovered that students exposed to problem-solving methods in biology achieved higher than the students exposed to the lecture method of teaching. This result also agrees with Maria (2018) whose findings showed that problem-solving had significant effects on the academic performance of the students of low ability. Students who were taught biology using a problem-solving strategy improved their academic performance and retained the learned concepts better than those taught using the lecture method. The result of the findings opposed the findings of Garba and Salim (2020) who concluded in their research that there was no significant difference in students' academic performance when taught geometry using a problem-solving instructional strategy. The study shows that problem-solving strategy caters to the diverse learning styles and needs of the students hence improving their academic performance.

In Table 3, the study revealed that both male and female students performed better when exposed to problem-solving strategy. Analysis using ANCOVA revealed that there is no significant difference between the mean performance scores of male and female students when exposed to problem-solving strategy. This implies that gender has no significant effect on student academic performance in genetics concepts in biology when exposed to problem-solving strategy and lecture methods. This result agreed with the findings of Akinwumi and Falemu (2017) who concluded in their study that no significant difference existed between male and female students when exposed to problem-solving strategy. The result also agreed with Garba and Salim (2020) who concluded that problem-solving methods affect both male and female students' attitudes toward geometry. The findings of this study opposed the findings of Ajibade(2019), in his study on sex differences and students' academic performance in secondary schools found that female students perform better than their male counterparts while Iwendi (2012) found male students outperform their female counterparts.

9. Conclusion

Based on the findings of this research study it can be concluded that problem solving strategy is superior to lecture method. Problem-solving strategy has a significant effect on students' academic performance in genetic concepts in biology. Problem problem-solving strategy enhanced student academic performance in genetic concepts in biology far better than the lecture method. It can also be concluded that gender has no significant effect on students' performance when exposed to genetic concepts in biology using problem-solving strategies and lecture methods. This means that both male and female students perform excellently when taught genetic concepts in biology using problem-solving strategies. Therefore, problem-solving strategy proved to be non-discriminatory for it is gender-friendly thereby enhancing the academic performance of both male and female students at near equal levels.

10. Recommendations

From the results of this study the following recommendations are therefore made:

1. Biology teachers should always adopt problem-solving strategies for teaching their students. This will enable the students to cater for themselves in their classrooms and hence, improve their learning outcomes.
2. Short-time training, workshops, and seminars should be organized by NGOs, ministries of education, and related government agencies to train teachers on how to make use of problem-solving strategies for teaching science subjects effectively
3. Based on this finding female and male students should be encouraged to vigorously pursue most of the biology-based courses since most of the genetics concepts in biology can now be explained using problem-solving strategy to concretize such concepts and will be easily conceptualized.

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