EFFECTS OF INDIVIDUALIZED PROBLEM-SOLVING INSTRUCTIONAL STRATEGY ON SECONDARY SCHOOL STUDENTS' PERFORMANCE IN DIFFICULT CONCEPTS IN BIOLOGY IN BENUE STATE, NIGERIA

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Abstract
This study investigated the effects of individualized problem-solving instructional strategy on secondary school students' performance in difficult concepts in Biology. Two research questions guided the study, while two hypotheses were formulated and tested. The study adopted quasi-experimental design and the population comprised 8,511 senior secondary two students from which a sample of 270 SSII students was selected from six public schools using multistage sampling technique. Data were obtained using Biology Performance Test (BPT). The instrument was validated and subjected to reliability analysis using Kuder-Richardson formula 21(KR_21), Biology Performance Test yielded a reliability of 0.85. Data collected were analysed using Mean and Standard Deviations to answer research questions while analysis of covariance (ANCOVA) was used to test the hypnoses at 0.05 level of significance. The findings of the study revealed that there is significant difference in mean performance scores of students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy and discussion method (F(1,175) = 290.228; P = 0.000<0.05). There is no significant difference in the mean performance scores of male and female students taught the seine difficult concepts in Biology using individualized problem-solving instructional strategy (F(1,87) = 0.393;P=0.0532>0.05). Based on the findings, it was recommended among others that Biology teachers could use individualized problem-solving instructional strategy to improve academic performance of their students in Biology.

Keywords: Individualized problem-solving instructional strategy, Discussion strategy, Difficult concepts, Biology, Performance and Gender.

Introduction

Science plays key roles in the in our daily life. As a result, the Federal Republic of Nigeria in its National Policy of Education introduced Science subjects such as Chemistry, Basic Science, Biology and Biology in the nation's secondary school curriculum. Biology is a natural science that entails the study of life and living organisms comprising of their structures, functions, growth, evolution, distribution and taxonomy. Biology serves as the foundation for further studies in scientific careers such as Medicine, Nursing and Pharmacy among others. Biology plays key roles in the health sector and other sectors such as agriculture, education economy.

Despite the roles of Biology, the academic performance of students in the subject has been reported to be poor (Samba, Ogbeba & Negedu, 2016). This is evident in the West African Examination Council (2015-2019) Chief Examiners' Reports on Students Poor Performance in Biology at Senior Secondary

School level. A research conducted by Samba *et al* (2016) revealed that students' poor academic performance in Biology is as a result of the instructional strategy employed by the teachers. Jirgba, Eriba and Achor (2018) observed that learning outcome is influenced by the instructional strategy employed by teachers. The contemporary science curriculum emphasizes a paradigm shift from instructional strategies that are teacher-centered to student-centered strategies such as individualized problem solving strategy.

Individualized problem solving strategy is a teaching strategy in which an individual student attempts to learn alone based on his/her ability using a number of instructional activities. According to Aluko and Olorundare (2017), individualistic instructional strategy is a teaching strategy in which an individual student works alone based on his/her ability while employing a variety of instructional activities to improve his/her understanding. In this study, individualized problem-solving reflects the ability of an individual student to use the knowledge structure on a particular concept or a topic to construct knowledge by himself or herself. This will help to identify the individual difference in learning as different people usually generate different meanings or understanding of concepts even in the same subject area. The success of this experience is based on the commitments of the individual concerned and proper procedures in problem-solving. It is a learning model that brings to bear and attempts to relate prior knowledge with that of the actual problem in question. It requires the use of cognitive abilities such as reasoning, thinking, power of observation, discrimination, generalization, imagination, ability to infer and draw conclusion, trying out novel ways as well as experimenting. This process can serve as a tool to promote an individual's conceptual understanding and can improve understanding of perceived difficult concept.

Performance is how well or badly that something is done. It could also mean how well or badly something works. Performance is a multidimensional concept that denotes the process of performing a task or an action and depends on the effectiveness or efficacy of the said task or an action (Okoyefi, 2014). Despite these efforts, performance in Biology has remained poor. The 2018 WAEC report indicated that candidates performed slightly poorer than the previous years due to difficulty of some concepts in Biology. This poor performance has denied many Nigerian students the opportunity of securing admission into high institutions of learning in medical, pharmaceutical and other science related fields thereby negatively affecting the manpower need of the nation.

Difficult concepts in biology are those concepts that students cannot understand easily. Students generally experience difficulties in sciences including biology which most students consider simple because of its low mathematical content (Umar, 2011). Samba and Eriba (2012), identified homeostasis, genetics, evolution, nervous coordination, cellular respiration, ecology, photosynthesis as some of the concepts that students find difficult in biology. Another study was carried out by Kyado (2018) in which he discovered through pre-survey exercise those concepts that are perceived as difficult in Biology by students. These includes aerobic respiration, tissue respiration, anaerobic respiration, ecology, energy flow in nature, conservation of natural resources, cell and organelles, photosynthesis, growth, transpiration, ecosystem, osmosis, Kreb's cycle, energy loss in ecosystem and glycolysis. This underscores the choice of topics such as

ecology, ecosystem, energy flow, cell as well as cellular organelles in this study.

Discussion method is an approach to teaching in which the teacher assumes the position of a strategic planner but dominates the process of teaching while allowing the students to also participate in the process. Discussion method is a variety of forum for open ended collaborative exchange of ideas between the teacher and students for the purpose of furthering students' thinking, learning, problem solving, understanding or literacy appreciation. In this study, discussion method is adopted as a conventional method to be compared with collaborative and individualized problem-solving instructional strategy as control. Participants present multiple points of view and respond to the ideas of others while reflecting on their own ideas in an attempt to build their knowledge (Tharp & Gallimore, 2017).

Studies already embarked upon in science education by (Ode & Akpoghol, 2020) and Olowe (2010) have indicated that gender among other factors may be responsible for the difficulty in students' perception. Since gender effect on biology performance has not been finally determined, it can be a factor to be considered in this study. In one of such studies (Ode, Aphoghol & Otor, 2020) found that males perform better in science. Whereas Olowe (2010) found that females perform better than males in science. Researchers including Basque and Odoh (2012) and Okwu and Akor (2012) have worked on collaborative or cooperative learning but specific research on problem-solving has not been much. Also it is very rare to find a work in which the effects of both collaborative and individualized problem-solving instructional strategy have been determined. Odoh (2012), worked on cooperative learning, Okwu and Akor (2012), worked on Polya's problem-solving and Ebutu (2015) on constructivist instructional approach but none of these studies combined two teaching methods to find out the outcome. Studies that have worked on individualized or collaborative concept-mapping or combined both include Okoyefi (2014) both individualized and collaborative, Novak (2010) individualized while, Johnson, Johnson and Smith (2009) worked on collaborative among others. However, these works were not on problem-solving instructional strategy. Various literatures have not completely addressed the effects of individualized and collaborative problem-solving instructional strategy on students' performance and interest in difficult concepts in biology. This study therefore, seeks to fill the gap that hitherto existed.

It is against this backdrop that the researcher, faced with the speculation that this gap exists in the use of collaborative and individualized problem-solving instructional strategy to improve knowledge decided to undertake this study which is meant to address the problem in the existence of this gap. The study intends to solve some problem of instruction while creating an avenue for further study by other researchers. The study therefore seeks to provide empirical evidence on the effects of individualized and collaborative problem-solving instructional strategy on students' performance and interest in difficult concepts in biology at senior secondary schools in the study area.

Statement of the Problem

Most science senior secondary school students find the learning of Biology difficult, tasking and full of abstract concepts with little understanding. Learning Biology to them is only possible through memorization. This is evident in the poor performance of students in Biology. According to West African Examination Council (WAEC, 2018) Chief Examiner's Report, Students' performance in Biology is

poor. This is blamed on the use of inappropriate strategies that fail to properly engage students in learn. As such, they are able to to solve Biology abstractive and high order thinking tasks. Efforts have been made by Biology educators and researchers (Aina & Akintunde, 2013; Wheeler & Blanchard, 2019) to improve students' performance across gender with little improvement. This study therefore, attempts to answer the question: What is the effect of individualized problem-solving instructional strategy on senior secondary two students' performance in difficult concepts in biology?

Purpose of the Study

The purpose of this study was to find out the effects of individualized problem-solving instructional strategy on secondary school students' performance in some difficult concepts in biology.

Specifically, the study sought to:

I. Find out the effect of individualized problem-solving instructional strategy on the mean performance scores of students in some difficult concepts in Biology.
II. Determine the mean performance scores of male and female students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy.

Research Questions

The following research questions guided the research.

1. What is the difference in the mean performance scores of Senior Secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy and those taught using discussion method?
2. What is the difference in the mean performance scores of male and female senior secondary two students taught the same difficult concepts in biology using individualized problem-solving instructional strategy?

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

1. There is no significant difference in the mean performance scores of Senior Secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy and those taught using discussion method.
2. There is no significant difference in the mean performance scores of male and female senior secondary two students taught the same difficult concepts in biology using individualized problem-solving instructional strategy.

Research Methodology

This study adopted a quasi-experimental design; specifically a non-equivalent, non-randomized, control group involving a pretest-posttest was used. Because of the experimental nature of this research, it is not feasible to randomly compose and group students as this will also bring about the disturbance of already existing class arrangement. The intact classes in the sampled schools were therefore used. Quasi-experimental design is a school friendly design which does not disrupt the structures of already existing classes. The population of this study was all senior secondary two students in Benue Zone C. According to the Ministry of Education science and technology Benue State (2019), the population of Biology students for the 2019/2020 session was 8,571 in 4,283 secondary schools. However, the target population of this study was all the 4,620

senior secondary two students offering Biology in Benue educational Zone C, comprising 2,661 males and 1,959 females.

The sample for this study comprised 270 SS II Biology students in six schools selected from Benue educational Zone C using multi-stage sampling technique. The schools were selected based on public schools and grant aided schools where there are experienced teachers of Biology. Biology Performance Test (BPT) was used for data collection. The BPT which was adapted from past West African Examinations Council (WAEC) questions between 2010 and 2019 and modified comprises 40 items multiple choice questions drawn from the topics of Ecology, Ecosystem, Energy flow, cell as well as cellular organelles. The test items were selected by the researcher based on the senior secondary school Biology syllabus. The instrument was then given to two experts in science education; from Benue State University Makurdi and one expert in measurement and evaluation from Federal University of Agriculture Makurdi for validation. The validators were requested to check the suitability, clarity of language and relevance of the objectives, scope and coverage of the test items and most importantly to check for face and content validity.

The validators observed that items for BPT conform adequately with the subject matter they were intended to test only that the number of items were many and was reduced from 50 to 40 but the BII needs to be refocused on Biology rather than the teacher and method and that some items were double barreled. The validators' comments, suggestions and recommendations were adequately used to improve the quality of the instrument. A trial test was carried out to determine the reliability of the research instruments and feasibility of the research design. The trial test schools selected were not part of the schools in which the research was carried out. The BPT was administered to 20 SSII students and their scores were subjected to reliability test using Kuder Richardson formula -21 (KR_21) and it yielded a reliability coefficient (r) of 0.85.

The instrument (BPT) was administered to the students at the beginning of the treatment exercise and the scores obtained were recorded as pretest scores. The treatment lasted for six weeks before the administration of posttest. The researcher organized training sessions for the research assistants for both experimental and control groups. The training sessions covered the areas of Biology taught, the use of lesson plans designed by the researcher, as well as the procedure for the administration of instruments. Mean and standard deviation were used to answer the research questions, while the Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 significant level. The choice of ANCOVA was based on the fact that the study used a quasi-experimental design of pretest posttest to determine the equivalence of the experimental and control groups and to take care of the possible lack of initial equivalence in groups, since intact classes are involved.

Results

Research Question One

What is the difference in Mean performance scores of Senior Secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy and those taught using discussion method?

Table 1: Mean and Standard Deviation of Performance Scores of students taught Biology using Individualized Problem-solving Instructional Strategy and Discussion Method

Strategy		PreBPT	PostBPT	Mean gain
Individualized Problem – Solving Instructional Strategy	Mean	36.67	76.50	39.83
	N	90	90	
	Std. Deviation	7.25	7.26	
Discussion Method	Mean	34.07	59.78	25.71
	N	90	90	
	Std. Deviation	7.16	6.84	
Mean difference				14.12

Table 1 shows the difference in the mean performance scores of Senior Secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy and discussion method. The Table shows that 90 students were taught Biology using individualized problem-solving instructional strategy and 90 students were taught using discussion method. The Table reveals that the mean performance scores of students taught Biology using individualized problem-solving instructional strategy was 36.67 with standard deviation of 7.25 during pre-test and 76.50 with standard deviation of 7.26 in post test. While the mean performance scores of students taught Biology using discussion method was 34.07 with standard deviation of 7.16 during pre-test and 59.78 with standard deviation of 6.84 in post test, Table 1 further shows that, the mean gain of students that were taught Biology using individualized problem-solving instructional strategy was 39.83 and those of students taught Biology using discussion method was 25.71. The difference in the mean performance scores of Senior Secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy and those taught using discussion method was 14.12 in favour of students taught Biology using individualized problem-solving instructional strategy.

Research Question Two

What is the difference in the mean performance scores of male and female senior secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy?

Table 2: Mean and Standard Deviation of Performance Scores of Male and Female Students taught Biology using Individualized Problem-solving Instructional Strategy

Gender		PreBPT	PostBPT	Mean gain
Male	Mean	37.03	76.02	38.99
	N	51	51	
	Std. Deviation	7.29	7.79	
Female	Mean	36.18	77.13	
	N	39	39	40.95
	Std. Deviation	7.26	6.55	
Mean difference				1.96

Table 2 shows the difference in the mean performance scores of male and female senior secondary two students taught the same difficult concepts in Biology using

individualized problem-solving instructional strategy. The Table shows that 51 male students and 39 female senior secondary two students were taught the same difficult concepts in Biology using individualized problem-solving instructional strategy. The Table reveals that the mean performance scores of male students taught Biology using individualized problem-solving instructional strategy was 37.03 with standard deviation of 7.29 during pre-test and 76.02 with standard deviation of 7.79 in post-test. While the mean performance scores of female students taught Biology using individualized problem-solving instructional strategy was 36.18 with standard deviation of 7.26 during pre-test and 77.13 with standard deviation of 6.55 in posttest, Table 5 further shows that the mean gain of male students taught Biology using individualized problem-solving instructional strategy was 38.99 and those of female students taught Biology using individualized problem-solving instructional strategy was 40.95. The difference in the mean performance scores of male and female senior secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy was 1.96 in favour of female students taught Biology using individualized problem-solving instructional strategy.

Hypothesis One

There is no significant difference in the mean performance scores of Senior Secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy and those taught using discussion method.

Table 3: ANCOVA of Performance Scores of Students taught Biology using Individualized Problem-solving Instructional Strategy and Discussion Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	13995.163[a]	4	3498.791	73.213	.000	.626
Intercept	39742.129	1	39742.129	831.608	.000	.826
Individualized	452.543	1	452.543	9.470	.002	.051
Gender	6.656	1	6.656	.139	.709	.001
Strategy	**13869.856**	**1**	**13869.856**	**290.228**	**.000**	**.624**
Gender * Strategy	12.030	1	12.030	.252	.616	.001
Error	8363.164	175	47.790			
Total	850739.000	180				
Corrected Total	22358.328	179				

a. R Squared = .626 (Adjusted R Squared = .617)

Table 3 reveals that $F(1,175) = 290.228$; $p = 0.000 < 0.05$. Since p is less than 0.05, the null hypothesis is rejected. This implies that there is significant difference in mean performance scores of Senior Secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy and those taught using discussion method. Thus, it can be concluded based on evidence from data analysis that there is significant difference in mean performance scores of Senior Secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy and those taught using discussion method. The partial Eta square of 0.624 was obtained for the strategy meaning that 62.4

percent of students' performance in difficult concepts in Biology can be accounted for by the strategy employed in the teaching of Biology.

There is no significant difference in the mean performance scores of male and female senior secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy.

Hypothesis Two

Table 4: ANCOVA of Performance Scores of Male and Female Students taught Biology using Individualized Problem-solving Instructional Strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	157.261[a]	2	78.630	1.508	.227	.033
Intercept	22891.067	1	22891.067	438.928	.000	.835
Individualized	130.100	1	130.100	2.495	.118	.028
Gender	**20.508**	**1**	**20.508**	**.393**	**. 532**	**. 004**
Error	4537.239	87	52.152			
Total	531397.000	90				
Corrected Total	4694.500	89				

a. R Squared = .033 (Adjusted R Squared = .011)

Table 4 reveals that F(1,87) = 0.393; p = 0.532 > 0.05. Since p is greater than 0.05, the null hypothesis is not rejected. This implies that there is no significant difference in the mean performance scores of male and female senior secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy. Thus, it can be concluded based on evidence from data analysis that there is no significant difference in the mean performance scores of male and female senior secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy. The partial Eta square of 0.004 was obtained for the gender meaning that only 0.4 percent of the Biology students' mean performance scores can be accounted for by their gender in individualized problem-solving instructional strategy class.

Discussion of Findings

One of the findings revealed that there is significant difference in Mean performance scores of Senior Secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy and those taught using discussion method. This means that Biology could be better taught using individualized problem-solving instructional strategy than discussion method. The finding agrees with that of Eka and Muluku (2018) that there was significant effect of individualized concept-mapping instructional strategy over the conventional lecture method. The finding also agrees with that of Sakiyo and Waziri (2015) that there is significant effect of individualized concept mapping instructional strategy in students' achievement in Biology than those of conventional lecture method.

The use of individualized problem-solving instructional strategy in the present study enabled Biology teachers to allow individual student work based on his/her ability while employing a variety of instructional activities to improve his/her understanding of difficult concepts in Biology class. This may be responsible for the significant difference found between individualized problem-solving instructional strategy and the discussion method in the present study. The

use of individualized problem-solving instructional strategy in the present study also enabled every student in Biology class to benefit from possessing an efficient problem-solving skill that is normally encountered on a daily basis. Even though some of the problems may be complex, an individual must attempt to solve a problem confronting him/her before asking others to assist if such an effort becomes unsuccessful. This may be responsible for the significant difference found in the present study.

The finding on the use of individualized problem-solving instructional strategy based on gender revealed that there is no significant difference in the mean performance scores of male and female senior secondary two students taught the same difficult concepts in Biology using individualized problem-solving instructional strategy. This implies that the use of individualized problem-solving instructional strategy is gender friendly in enhancing students' performance in Biology. The finding agrees with that of Sakiyo and Waziri (2015) that there is no gender difference in achievement using individualized concept-mapping instructional strategy. The finding also agrees with that of Daramola (2012) that there is no significant difference in performance of males and females students that participated in the study. However, the finding disagrees with that of Eka and Muluku (2018) that there is significant difference in the achievement of male and female students taught using individualized concept-mapping strategy in favour of males.

Gender permeates Biology class when individualized problem-solving instructional strategy was used to teach students. The present study found no significant difference in the mean performance scores of male and female students in individualized problem-solving instructional strategy class. This is because the effective use of individualized problem-solving instructional strategy is capable of bridging the gender gap as findings have shown that the instructional strategy is gender friendly. In the individualized problem-solving instructional classroom, an individual student attempts to learn alone based on his/her ability using a number of instructional activities. Therefore, not only are students more likely to learn and teachers more likely to bring their creativity to the fore, other opportunities are successful solution to the problem of perceived difficult concepts in Biology. The success recorded by both male and female students is responsible for the bridge of gender gap in students' performance in individualized problem-solving instructional strategy class.

Conclusion

The use of individualized problem-solving instructional strategy enhanced students' performance in Biology. These strategy have enhanced the learning of Biology because they are learner friendly and have created opportunity for active participation of students with the teacher serving as a guide. The effects of this strategy have shown that performance in Biology is a function of method and does not depend on gender. The implications of the findings therefore, are that individualized problem-solving instructional strategy enhance students' performance and problem-solving abilities in Biology as a subject.

Recommendations

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

1. Biology teachers should be trained by government through the ministry of education on the use of individualized problem- solving instructional strategy both in teacher training institutions and in-service training programmes

2. Biology teachers should use individualized problem-solving instructional strategy to improve academic performance and problem solving skills of their students in Biology.
3. Since the findings of this study have revealed that individualized problem-solving instructional strategy to be gender friendly, Biology teachers should endeavour to give both male and female equal opportunities in learning Biology.

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