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EFFECTS OF INQUIRY BASED INSTRUCTION ON SENIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN BIOLOGY IN ENUGU EDUCATION ZONE

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Abstract
The objective of the study was to investigate the effect of inquiry based instruction on senior school students' achievement in biology in Enugu Education Zone of Enugu State. Three research questions were raised to guide the study. Quasi experimental research design involving an experimental group and one control group was adopted for the study. The study was carried out in senior secondary schools in Enugu Education Zone involving SS 1 students. Population size was 5386 SS1 students and the sample size was 174 students made up of 91 males and 83 females. Biology Achievement Test (BAT) was used for data collection. Mean statistic was used to answer the research questions while hypotheses were tested with ANCOVA statistic at 0.05 level of significance. The findings are that students taught biology concept with inquiry based instructional approach performed better than students taught with lecture method. It was recommended that government should make available all the instructional materials that support the use of inquiry based instructional method for teaching and learning of biology in all secondary schools, school administrators should always supervise and encourage the use of inquiry based instructional approach in teaching of biology in secondary schools,.

Keywords: Inquiry-based Instruction, Achievement and Biology

Introduction

Man and his entire environment are daily faced with challenges. In pursuit of solutions to these challenges, manhas clungto science and technology as bedrock to salvaging humanity from problems of life. Science and technology have helped man socially, politically, economically, aesthetically and philosophically shaped the world and brought about human civilization which has led to economic profit, human development and general advancement.

Education is aimed at sustainable national development. Science Education is the field concerned with sharing scientific knowledge and methods with people not considered part of

scientific community (Ude, 2011). Science education which is seen as the acquisition of concepts has been identified as one of the major bedrocks for sustainable development that are important as concerned with science (Nnamdi, 2014). The need for innovation and technology advancement led to the emergence of Science, Technology, Engineering and Mathematics (STEM) as part of top national agenda for many governments in recent years. To achieve the aims and objectives of STEM, science is taught in secondary schools as physics, chemistry, biology and mathematics (Keith, 2014). Good achievement in these subjects enables students gain admission into universities and other institutionsof higher learning to study engineering, biochemistry, microbiology, anatomy, geology, pharmacy among others (Belfi, 2016).

Each branch of science has very important roles to play in the achievement of the science education goals and biology as a branch of science is not left out. Biology is the study of life and pervades all aspects of everyday life. People rely on living things and their products for food, homes, personal care, fuel and medicines (Dostson, 2018). Despite the important roles biology plays in the society, students' academic achievement in biology examination has persistently been below expectation. This view is by the West African Examination Council, Chief Examiners Report (2015 , 2017 and 2018) and National Examination Council (2016 and 2018) to back up the ugly situation. The report from WAEC stated that the performance of candidates in WASSCE 2018 was poorer than that of 2017 with a raw mean score of 30 and standard deviation of 9.00 when compared with the mean score of 31 and the standard deviation of 11.92 in 2017. Science subjects are activity oriented which make them real through actual experiences Abraham& Saglam, (2010) observed that teachers shy away from activity oriented teaching methods (student centred) which involves practical work or mode of study. They instead rely in the teaching methods devoid of practicals by students such as lecture method which is teacher centred.

Commonly used teaching methods include inquiry based method, lecture method, demonstration method, target task, discovery learning, cooperative learning among others. Inquiry- based instruction, according to gradepowerlearning.com (2018) is an approach to learning that emphasizes the student's role in the learning process rather than the teacher teaching students what they need to know. Dotal (2015) opined that inquiry based learning method include problem based learning and it is usually used in science instruction and projects as well as research. Bayram (2013) opined that inquiry based learning refers to any pedagogy that utilizes presentations or student centred activities to develop in the students the confidence and ability to do sciences on their own. Inquiry based instruction encourages students to engage in the process of gathering data and seeking answers to their questions. This method of instruction stirs students to action. Students are encouraged to develop insightful questions and understand context.

Lecture method on the other hand, is the traditional method of teaching applied in educational institution (Umar, 2012). Lecture method is a one way channel of communication of information. Student's involvement in this teaching method is just to listen and take down notes of important points. The teachers are moreactive while the students are passive though teachers also ask questions to keep the students attentive (Meenu, 2014). This study therefore investigates the effect of inquiry based instruction on senior secondary students' achievement in biology

The methods of instruction – Inquiry-based and lecture method are all aimed at increasing the students' academic achievement which

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indicates the extent to which a student, teacher or institution has achieved their short or long term educational goals (Boraddu, 2019). To actually measure the students' academic achievement, one of the characteristics of the learner, according to Dorgu (2015) which should be considered is the gender of the learners

Gender is the word used to describe whether an individual is a male or female. In the education world, males and females are found to have different academic interest, choice of subjects, extracurricular activities and as well perform differently in their school tests and examination. According to Adeneye (2011), the girls have ability to spend more time reading and doing homework than boys who would rather spend their free time in virtual world contribute to their better performances. The study therefore investigates the effect of inquiry based instruction on senior secondary school student's achievement in biology.

There have been reported failures in school certificate examinations in the sciences, biology inclusive. Studies have shown that most schools engage in the conventional method for teaching (lecture method) and this could be the reason for students poor achievement in biology which has led to decrease in number of Doctors, Pharmacists, Biologists, Biochemist, Agronomists etc. who would have helped to fight hunger, disease and food insecurity in Nigeria. There is fear that if this problem is left unattended to, Nigeria may not be able to attain the zenith of her technological development. The prime question therefore is what will be the effect of inquiry based instructional method of instruction on senior school student's achievements in biology in Enugu Education Zone.

Purpose of the Study

The main purpose of this study is to determine the effect of inquiry based instruction and lecture method on students' achievement in biology in Enugu Education zone. Specifically, the study intends to determine:

1. the impact of inquiry based instructional approach and lecture method of instruction on students achievement in biology
2. the impact of inquiry based method of instructional approach on the achievement of male and female students in biology
3. The interaction effect of method and gender on students' achievement using lecture method.

Scope of the Study

The study focused on the effect of inquiry based instruction on senior secondary school students' achievement in biology. The interaction of gender on the effectiveness of the two teaching methods was considered. The study was restricted to only the senior secondary school class one students in whose scheme of work the topic used for the study is contained. The choice of SS1 students for the study was justified by the researchers'belief that the findings and the recommendations of the study could be utilized by both the teachers and students for the remaining two years (SS 2 and SS3) in the school before they sit for SSCE (Senior Secondary School Certificate Examination). The content scope chosen for the study is phototropism (Tropic movements). The contentscoveredinthestudy include:Introduction to need for response to external stimuli by organisms, Types of Responses (Taxis (Tactic movement), Nastic movement (Nastism), Tropic Movement (Tropism)), Definition of Taxis, Nastism& Tropism and Phototropism, Geotropism and

Hydrotropism as types of Tropism. The geographical scope of the study is Enugu Education Zone.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of students taught biology with inquiry based instructional approach and lecture method?
2. What are the mean achievement scores of male and female SS 1 students taught biology concepts with inquiry based instructional approach?
3. What is the interaction effect between method of instruction and gender on SS 1 students' achievement in Biology?

Hypotheses

The following null hypotheses (Ho) were formulated and tested at 0.05 level of probability.

1. There is no significant difference in the mean achievement scores of SS1 students taught biology concept using inquiry based instruction and those taught with lecture method of instruction.
2. There is no significant difference in the mean achievement scores of male and female SS1 students taught biology concept using inquiry based instructional approach.
3. There is no significance difference ofinteraction effect between gender and method on students' academic achievement in biology.

Methods

Quasi-experimental non-equivalent design was used for this study. Specifically, the pre-test –post-test quasi experimental design was adopted. The population of this study is 5836 SS1 students (PPSMB 2017/18). This study was carried out in Enugu Education Zone, in Enugu State. There are 31 public secondary schools in Enugu Education Zone which were classified into co-educational (male and female) and single sex secondary schools. Because gender is involved in the study co- educational schools were used. Out of 31 schools, 22 are co-educational schools, two of which were purposively sampled due to their proximity. The student sample consist of 174 students comprising of 91 male students and 83 female. Simple random sampling technique was used to sample two classes from four streams in each school. Biology Achievement Test (BAT) was used for data collection. The test consist of 20 multiple choice test questions. The scores of the students were converted to percentage (total 100%). The researchers carried out a trial testing in one secondary school in Enugu not involved in the study.

The instrument was validated by three specialists, two from Department of Science and Vocational Education and one from Department of Educational Foundations all from Godfrey Okoye University, Enugu. The reliability of the instrument was established using Cronbach alpha to obtain the reliability coefficient index value of 0.972, indicating that the instrument was consistent and reliable. Pre-Biology Achievement test was administered to both experimental and control groups before the treatment begins. Twenty minutes was allowed for the test. The test enabled the researcher establish the pre-experimental abilities of the subjects. After the treatment, a Post Biology Achievement Test was given to the two groups again. The post-test was the same as the pre-test

except that the numbering of items were altered in the post test.

Experimental Procedure

Two intact classes made up of both males and females (males 46 in number and females 40 in number in class A and males 48 and females 40 in number in class B) were assigned with inquiry based instruction method and lecture method respectively. The inquiry based instruction and the lecture methods were identical in terms of content, basic instructional objectives and mode of evaluation. Both groups were given a pre-test (BAT) which lasted for 20 minutes before the onset of the treatment. The major difference between the two types of treatment was the instructional technique adopted. The inquiry based instruction in the experimental procedure involved the teacher and the students. The teacher posed questions on tropic movements, specifically on phototropism and guided the students.The students were required to build four Boxes $2A^s$ and $2B^s$ where box A had an opening by the side while Box B had opening at the top to allow sunlight. The students were grouped into four, two groups per abox.The students were asked to gather soil and add manure to the soil in four nylon bags. Then three maize seedlings were planted in each bag. Then the bag containing sand, maize and manure will be watered. Then two of the bags were placed in box marked 'A' and the other two on box marked 'B'. Then the students were asked to water the plants daily and record their findings. Then another group of students were taught the concept of tropic movements (with emphasis on phototropism) using the lecture method.The researchers adopted the following procedures to ensure that the extraneous and intervening variables which might introduce bias into the study were eliminated or controlled. The data was analyzed using mean and standard deviation. Hypotheses were tested using ANCOVA at 0.05 level of significance.

Results

The results were presented according to the research questions and the hypotheses that guided the study.

Research Question I

What are the mean achievement scores of students taught biology with inquiry based instructional approach and lecture method?

Table 1: Mean and standard deviation of achievement scores of students taught Biology using inquiry based instructional approach and lecture method

Group	No. of Students	Pre-Test Mean (X)	Pre-Test SD	Post-Test Mean (X)	Post-Test SD	Mean Gain
Experimental	86	4.88	2.23	19.37	3.27	14.49
Control	88	4.60	2.19	13.52	3.18	8.92
Total	174					

From Table 1, it was observed that the pretest and posttest of the experimental group mean (X) score are 4.88 and 19.37 and standard deviation (SD) scores of 2.23 and 3.27 respectively. On the other hand, it was also observed that control group has pretest and posttest mean scores of 4.40 and 13.52 with standard deviation scores of 2.19 and 3.18 respectively. The positive mean deference for the experimental group is 14.49 while that of control group is 8.92 signifying superiority of the experimental group over the control group. This shows that use of inquiry based instructional approach as a method of teaching biology makes learning more practical than abstract.

Research Question 2

What are the mean achievement scores of male and female SS1 students taught biology concept with inquiry based instructional?

Table 2: Mean and standard deviation of achievement scores of students taught biology using inquiry based instructional approach and lecture method.

Group	No of Student	Pre-test Mean(X)	SD	Post-test Mean (X)	SD	Gain Mean
Male	44	4.88	1.92	18.93	3.08	14.05
Female	42	4.92	2.52	19.83	3.44	14.91
Total	86					

From Table 2, it was observed that the pretest and posttest of the male students mean (X) scores are 4.88 and 18.93 and standard deviation (SD) scores of 1.92 and 3.08 respectively. On the other hand, the pretest and posttest mean scores of female students are 4.92 and 19.83 with standard deviation scores of 2.53 and 3.44 respectively. The positive mean difference for the male is 14.05 while that of female is 14.91 signifying superiority of the female over the male. This shows that use of inquiry based instructional approach as a method of teaching biology favours female students more than the male students, though with insignificant margin of 0.9

Hypothesis 1

H_{01}: There is no significant difference in the mean achievement scores of SS1 students taught biology concept using inquiry based instruction and those taught with lecture method of instruction.

Table 3: Analysis of Covariance (ANCOVA) for the mean achievement scores of SS1 students taught biology concept using inquiry based instruction and those taught with lecture method of instruction.

	Sum of Squares	Df	Mean Square	F	Sig.
Contrast	1349.361	1	1349.361	221.439	.000
Error	1042.004	171	6.094		

Table 3 shows the ANCOVA table for the achievement scores of SS1 students taught biology concepts using inquiry based method of instruction and those taught with lecture method of instruction. It is observed from the table that f is 221.439 and its probability is 0.000. Since the probability of f is 0.000 and the value is less than 0.05 (5% level of significance), the null hypothesis is rejected. This means that there is significant difference in the mean achievement scores of SS1 students taught biology concept using inquiry based instruction and those taught with lecture method of instruction.

Hypothesis 2

H_{O2}: There is no significant difference in the mean score of male and female SS1 students taught biology concept using inquiry based instructional approach.

Table 4: Analysis of Covariance (ANCOVA) for the mean scores of SS1 students taught biology concept using inquiry based instruction approach.

	Sum of Squares	df	Mean Square	F	Sig.
Contrast	17.659	1	17.659	2.758	.101
Error	531.529	83	6.404		

Table 4 shows the ANCOVA table for the scores male and female SS1 students taught biology with concept using inquiry based instructional approach. It is also observed from the table that the calculated/observed f is 2.758 and its probability is 0.101. Since the probability of f is 0.101 and the value is greater than 0.05 (5% level of significance), the null hypothesis is accepted. This means that there is no significant difference in the mean score of male and female SS1 students taught biology concept using inquiry based instructional approach.

Hypothesis 3

Ho_3 There is no significant difference in the interaction effect between gender and method on students' academic achievement in biology.

Table 5: Analysis of Covariance (ANCOVA) for the interaction effect of method and gender on students' achievement in biology.

Tests of Between-Subjects Effects

Dependent Variable: TEST

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1510.702[a]	3	503.567	48.366	.000
Intercept	47059.925	1	47059.925	4519.956	.000
GENDER	.050	1	.050	.005	.945
METHOD	1510.488	1	1510.488	145.078	.000
GENDER * METHOD	4.678	1	4.678	.449	.504
Error	1769.970	170	10.412		
Total	50257.000	174			
Corrected Total	3280.672	173			

a. R Squared = .460 (Adjusted R Squared = .451)

Table 5 shows the ANCOVA table for the interaction effect of method and gender on students' achievement in biology. It is observed from the table that the probability of f-ratio of gender*method interaction is 0.504. Since the probability of f-ratio/calculated is 0.504 and the value is greater than 0.05 (5% level of significance), the null hypothesis is accepted. This means that the interaction effect of method and gender has no statistically significant effect on students' achievement in biology.

Discussions

The result of the study revealed that there is wide disparity in the achievement scores of SS1 Students taught Biology concept using inquiry based instructional approach and those taught with lecture method. The inquiry based approach makes teaching and learning of Biology more practical. Engaging students in experiment increases their commitment. The result also shows that there is significant difference in the mean achievement scores of SS1 students taught Biology concept using inquiry based instruction and those taught with lecture method. This finding agreed with the study of Uche (2013) who stated that students taught Biology using inquiry method performed far better than those taught using conventional method in secondary schools in Abuja.

Nevertheless, the result from research question two revealed that there is little and insignificant difference in the mean achievement scores of male and female SS1

students taught Biology concept with inquiry based instructional approach. More so, result from hypothesis two confirms that there is no significant difference in the mean score of male and female SS1 students taught biology concepts using inquiry based instructional approach. It means that gender is not a sensitive factor to inquiry based instructional approach in teaching and learning of Biology in secondary schools. Result from research question three revealed that the interaction effect between gender and method has no significant effect on students' achievement in biology.

Conclusions

The study centers on effect of inquiry based instruction on senior secondary students' achievement in Biology in Education Zone. The findings revealed that Students taught Biology Concept with inquiry based instructional approach performed better than students taught Biology Concept with lecture method in Enugu Education Zone.Also, the difference in the achievement mean scores of male and female students taught Biology concept with inquiry based instructional approach are insignificant. This shows that inquiry based instructional approach are not gender sensitive. The interaction effect of gender and method on students' achievement in biology was not statistically significant. It shows that the interaction between gender and method has no significant effect on students' achievement scores inbiology.

Recommendations

The following recommendations were made based on the findings of this study:

1. Government should make available all the instructional materials supporting inquiry based instructional approach in the teaching and learning of Biology in all the secondary schools.
3. School administrators should always carry out regular supervision of teachers to confirm the use of inquiry based instructional approach in the teaching of Biology in secondary schools.
4. Seminars and workshop should on well-defined intervals conducted for Biology teachers in order to update them in inquiry based method of teaching Biology.

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