Effects of Guided-Inquiry and Demonstration Method on Science Process Skills Acquisition among Secondary School Biology Students in Anambra State

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Abstract
This study was designed to investigate the effect of guided-inquiry and demonstration methods of teaching on science process skills acquisition among secondary school biology students. The design of the study was quasi-experimental, specifically, the non-equivalent, pretest-posttest was used. One hundred and fifty (150) Senior Secondary one biology students in co-educational Government owned schools formed the sample of the study. Three (3) groups co-educational schools were randomly drawn from the fifty (50) co educational secondary schools in Ogidi education zone in Anambra state. Intact classes were randomly assigned to two experimental groups and a control group. The experimental groups one and two were taught using guided-inquiry and demonstration methods respectively. The control group students were taught using the conventional method. Two research questions and two null hypotheses were formulated to guide the study. A Test of Science Process Skills Acquisition (TOSPSA) of twenty (20) items was developed and used in obtaining data on students' acquisition of the process skills of science. The data were analyzed using mean and standard deviation to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The result revealed that students taught using the guided-inquiry method performed significantly better than those taught using demonstration and conventional methods. It was recommended that teachers should use guided-inquiry method of teaching that challenges students to be involved in the classroom, this will spur their interest to learn. In-service training and workshop should be organized by the Ministry of Education to train teachers in the use of importance of activity method.

Keywords*: Effects, Guided inquiry, Demonstration method, Process skills, Acquisition and Biology*

INTRODUCTION

The scientific and technological development of any nations depend on a qualitative and functional science, technological and mathematics education. It is through qualitative and functional science education that appropriate biology skills are transmitted to the students. Research have shown that it is the process of science that is more important than the teaching of the product of science (Nwosu, 2003; Nwagbo and Chukelu, 2011).

The guided inquiry method is described as a problem solving method in which learner interact with the environment to test their hypotheses, and as a result make generalization (Nnorom, 2008). Also Martins and Oyebanji (2000) noted that in guided inquiry, teaching is conceived as a set of activity requiring the performance of mental process such as observing, classifying, measuring, predicting, describing and inferring. Practical activities were designed to enhance the development of these process skills. Guided inquiry employs either the

inductive or deductive approach to learning. The guided enquiry is employed through deductive method when a learner is expected to discover through the established principles, solution to a particular problem, while guided inquiry is adopted through inductive method when the learner is exposed on how to discover for himself the general principles on which the solution is based (Nnorom, Ezeoba & Muokebe; 2015). Demonstration method is the practical method of teaching where the teacher display step by step of doing things. In using this method, much emphasis is used on concrete illustrations which enable the students hear and at the same time see what is being displayed.

The search for more effective approach to the teaching and learning of science that will enhance process skills acquisition has persisted over the years. Process skills are the abilities, potentials, and technical know-how which can be developed by experience and used in carrying out mental operations and physical actions (Ibe and Nwosu, 2003). Possession of these skills is basic to scientific inquiry and the development of intellectual skills and attitudes needed to learn concepts. The process skills have the enduring quality that will contribute to the students abilities to answer questions and solve problems even when the information base of science and technology changes. The National Policy on Education (2008) recognizes the importance of process skills in the solution of the nation's scientific problems. It has as one of its national education goals, the acquisition of appropriate skills, both mental and physical as equipment for the individual to live in and contribute to the development of his society.

According to Ibe (2004), the American Association for the Advancement of Science (AAAS) developed a programme known a science A process Approach (SAPA). This programme sees science process as true essence of science. The programme was designed to improved children's skill in the process of science. Ajunwa (2000) reported that science educators and curriculum experts modified them by either expanding or condensing them to suit their special needs or expectations. The Nigerian Educational Research Council in 1990 therefore, modified and came up with fifteen (15) science process skills. These are:

I. Observing II. Measuring; III. Classifying; IV. Communicating; V. Predicting; VI. Inferring VII. Using number; VIII. Using space/time relationship; IX. Questioning; X. Controlling variables; XI. Defining operationally; XII. Formulating models; XIII. Hypothesizing; XIV. designing experiment; XV. Interpreting data

Realizing the importance of science process skills as solution to scientific problems, the federal government, among other things, states as one of the national goals of education in Nigeria that "education should aim at helping the child in the acquisition of appropriate skills, abilities and competencies both mental and physical as equipment for the individual to live in and both mental and contribute to the development of the society" Federal Republic of Nigeria (FRN; 2004:29) in order to realize this goal association such as Science Teachers Association of Nigeria (STAN) and Nigerian Integrated Science Project (NISP) were set up by the government to look into the various curricula used at various levels of Nigerian educational system. The various curricula developed, have their objectives which have to be achieved for a successful science education and attainment of the national goals and aspirations. These goals and aspirations cannot be realized except through the effective effort of the classroom teacher.

According to Nnorom (2016), a number of factors have been identified as contributing to the non-acquisition of skills by secondary school students which invariably lead to poor performance and one of the factors is the teacher variable, that is, the teachers' method of teaching. Furthermore, Okoli (2006) indicated that many science teachers prefer the traditional expository/lecture method of teaching that is, teaching technique in which one

person, the teacher, presents a spoken discourse on a particular subject and shy away from activity-oriented teaching methods which are student centered (such as inquiry method, discovery method, investigative laboratory approach). Nwagbo (2006) observed that such teacher-centred approach which places the teacher as the sole possessor of knowledge and the students as passive recipients of knowledge may not enhance achievement or promote positive attitude to biology. Apart from teaching methods, gender is also implicated in students' achievement in science.

The issue of gender and gender stereotyping permeate every aspect of human endeavour. Okeke (2007) observed that the consequences of gender stereotyping cut across social, economic, political and educational development, especially in the areas of science and technology. However, there have been conflicting reports in respect to gender and achievement in science (Abonyi, 1998, Nnorom & Obi, 2013). This study is therefore expected to contribute to the debate.

The Problem

Science learning is expected to produce individuals that are capable of solving their problems as well as those of the society. Such individuals are expected to be autonomous, confident and self reliant. Science and technology constitute the basis of advancement in nearly all fields of human endeavours. Obiekwe (2008) reported that all is not well with science instruction in Nigeria secondary schools, and noted that science teaching lays extreme emphasis on content and the use of "chalk and talk" method neglecting the practical activity method which enhances teaching and learning. This negligence and 'shy-away' attitude from activity oriented-method of teaching has led to abstraction which makes the students less active and more prone to rote memorization. Based on this, the Federal Government of Nigeria is emphasizing "the teaching and learning of science process and principles which will lead to fundamental and applied research in the sciences at all levels of education" (FRN, 2004:29). A lot has been done to improve science teaching in secondary schools in Nigeria. In spite of that, students continue to perform poorly in science subjects, of which biology is one. This situation has created the need for more effective teaching methods. It then becomes necessary to explore the efficacy of alternative method of redressing this situation.

Therefore, the main purpose of this is to investigate the effects of guided-inquiry and demonstration on science process skills Acquisition among secondary school biology students.

Research questions

The following research questions guided the study:

1) How does the guided-inquiry method of instruction compare with demonstration and the conventional methods in affecting senior secondary one (SS1) biology students acquisition of science process skills?
2) To what extent does gender interact with the teaching methods in influencing students acquisition of science process skills?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

$H0_1$ There is no significant difference in the mean score of students taught biology by guided inquiry and those taught by demonstration and the conventional methods respectively.

$H0_2$ There is no significant difference in the mean performance of male and female when exposed to each of the teaching methods investigated.

Method

The design of the study was quasi-experimental using pretest posttest non-equivalent control group. The study was carried out using the senior secondary one (SSI) biology students in Ogidi Education Zone of Anambra State. From the 50 co-educational secondary schools in Ogidi Education Zone, three (3) were randomly selected. One hundred and fifty students (150) from intact classes formed the sample. The instrument used for data collection was a researcher made test of Science Process Skills Acquisition (TOSPSA). The 20 item tests was made up of two sections. These items were distributed among the process skills of observing, classifying measuring. Hypothesizing, experimenting and inferring. Section one (1) was a practical exercise, while section two (2) was of multiple-choice type. The items were generated from the two topics selected from the SS1 biology curriculum namely: (1) living and non living things (2) food test (proteins, Carbohydrates and lipids).

The reliability of the (TOSPSA) was determined using test-retest reliability method. The reliability coefficients obtained were 0.79 and 0.79 for sections one and two respectively.

The researcher coached and supervised the regular class teachers of the experimental groups and the control group using the lesson plan and lesson notes given to them in a mock teaching exercise to ensure that they did not deviate form the instructions given to them. The same test served as both pre-test and post-test. The post test was administered after an interval of six weeks.

The score obtained from the pre-test were analyzed using mean and standard deviation for answering the research questions while analysis of covariance (ANCOVA) was used for testing the hypotheses at 0.5 level of significance.

Results

Table 1: Descriptive Statistics for the effects of each of the three methods on students interest in biology

	Pretest		**Posttests**		
Treatment X Gender	mean	SD	Mean	SD	Gain score
Experimental treatment Guided-inquiry (All Students).	15.10	4.68	35 .42	10.84	20.32s
Male	15.64	4.59	38.32	12.50	22.68
Female	14.56	4.80	32.52	8.78	17.96
Demonstration (All students)	15.18	3.35	26.22	7.96	11.04
Male	15.96	3.52	27.049.15	11.08	
Female	14.40	3.06	25.40	6.65	11.00
Conventional (control)(All students	14.28	4.03	21.84	6.59	7.56
Male	14.76	4.11	21.48	7.63	6.72
Female	13.18	3.98	22.2	5.48	8.40
Total	14.85	4.05	27.83	10.83	12.98

The guided-inquiry group scored higher than the demonstration and conventional groups in the TOSPSA test items with a mean score of 35.42 followed by the demonstration group with a mean score of 26.22 while the conventional group had the least mean score of 21.84.

Table 2: Analysis of covariance (ANCOVA) of students acquisition of science process skill by treatment and by gender.

Source of variation	Sun of squares	Degree of freedom	Mean of squares	F	Sign of decision
Covariates	2554.776	1	2554.776	42.712	00
Pretest	2554.766	1	2554.776	42.712	00
Main effects	4408.368	3	1469.546	24.567	00s
Treatment	4368.955	2	2184.478	36.521	00
Gender	48.084	1	48.084	.084	.37
2 way interaction	273.006	2	136.503	2.282	10
Treatment x Gender	273.139	2	136.570	2.282	10ns
Explained	7236.139	6	1206.023	20.163	00
Residual	8553.354	143	59.814		
Total	15789.439	149	105.97		

The teaching methods as the main effect were significant in the biology students' skills acquisition (F=.00) At .05 level of significance, there is significant difference in the mean methods on acquisition of the science process skills by students exposed to the different methods of teaching,

Table 2 showed that the performance of male and female students in the aggregate process skills acquisition as measured by the TOSPSA test items, was not significant (F=37, p< 0.5). both male and female students taught using guided-inquiry method consistently had superior potentials over the demonstration group who in turn performed better than those exposed to the conventional method.

In table 2 also, F value of 804 was significant of the probability level of 37 which is greater than .05. This means that gender does not combine with teaching method of affects students performance. Since there is no interaction in this study due to teaching method and gender. One would assume that the differential effects observed in performances of students in this study may be attributed to the teaching methods which enhanced science process skills acquisition by the male and female students used in the study.

Table 3: Multiple classification Analysis

			Unadjusted mean	Adjusted + Cod.Bet	Multiple R	R2
Treatment	Guided inquiry	50	7.59	2.37		
	Demonstration	50	-1.61	-1.9	066	0.4
	Conventional	50	-5.99	-5.46		
	Male	75	1.12	0.57		
	Female	75	-1.12	-0.57s		

In table 3, the means for the three levels of treatment were 7.59,-1.61 and 5.99 for these groups respectively and as expressed as deviation from the grand mean. Since the deviation in guided-inquiry is higher than those of demonstration and conventional methods, any variation in performance is due to the guided-inquiry methods.

Discussion of the Findings

The findings of this result revealed that, the active involvement of the students in guided-inquiry class gave rise to efficient learning. This result can be explained by the findings of

Bruner (1965); Anyaegbunam (1997); Ibe & Nwosu (2003). Students participation in teaching-learning sequence leads to a more scientific and acceptable understanding of concept and enhances the levels of acquisition of science process skills. Guided-inquiry method of science teaching can lead to new knowledge, new discoveries and new insight, science teaching and learning therefore should be hands-on methods for children. The guided-inquiry method sees the learner as an active information-processing organism.

Although treatment did significantly improve the level of acquisition of the science process skills among students in the study, these levels were not high. This should be expected because studying science as inquiry for process skills acquisition is not common in our schools. According to Ibe and Nwosu (2003), Okigbo and Okeke (2011) students lack firm background in science process skill. The short period used for the study could not be expected to completely change the effects of years of exposure to teaching which had used the conventional methods (e.g drill and lecture) wherein the process of inquiry had not been emphasized. This is in support of the finding of Gardiner (1980) that when you give a man a fish he eats for a day but when you teach a man to fish, he eats for a life time.

Conclusion and implications of the Study

From the finding of the study these conclusions are drawn. The use of guided-inquiry teaching method in the classroom helped the students to acquire the science process skill which make the understanding of science concepts easier and learning less difficult.

The study has projected biology to both teacher and students as an action subjects as opposed to one of mere talking and listening. Therefore, it is hoped that all personnel involved in the formulation and implementation of policies in the realm of science education in Nigeria would come to realize the significance of this theme and uphold its tenets because "hear and for get, see and remember, do and understand" is widely accepted as the ideal for science teaching and learning.

The science process skill as tools for learning and problem-solving should not only be acquired at all level of our educational system but should be acquired to a reasonable degree. To this end, it is being proposed that a more intensive teacher education programme be pursued at all levels of our educational system. This will no doubt increase teachers competencies. Having been adequately trained there will be increased chances of teachers use a guided-inquiry method to teach students, placing them under problems solving situations, allowing them carry out investigation and given materials to manipulate while the teacher acts as the facilitator. When students are taught they will do better and also graduate with greater confidence to tackle scientific problems and develop the necessary scientific attitudes. Having been adequately trained, there will be increased chances of students acquisition of the science process skills and graduation with greater confidence to tackle scientific problems and develop the necessary scientific attitude.

Recommendations

The following recommendations were made:

- Teachers should encourage students to develop interest in practical activity by engaging them in practical and providing instructional materials that will challenge them to be actively involved during science lessons.
- Ministry of education and professors organization not STAN should organize workshops, seminars and conferences for biology teachers.
- Biology concepts should be taught with innovative teaching methods like guided inquiry so that the students will do science instead of learning about science.

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