

Effects of Process Oriented Guided Inquiry Learning on Students' Interest and Achievement in Biology in Senior Secondary Schools In Federal Capital Territory, Abuja

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ABSTRACT: The study was conducted to determine the effects of Process Oriented Guided Inquiry Learning on students Interest and Achievement in Biology in Senior Secondary Schools in Federal Capital Territory, Abuja. The study was guided by two research objectives, which were subsequently translated into two research questions and two null hypotheses. The study employed quasi-experimental design. Specifically, the study applied pre-test, post-test non- randomized, control group. The population of this study sampled randomly comprised of all SS II Biology students in public Senior Secondary Schools in Federal Capital Territory, Abuja. The sample size of the study was 102 senior secondary two (SS II) Biology students drawn through simple random sampling and purposive sampling procedure. The instruments used for data collection was Biology Interest Scale (BIS) developed by the researcher. The instrument was validated by three experts, two from Department of Science and Environmental Education and a Biology teacher from the sampled school was selected to check the face validity, two qualified Biology teachers from the sampled school were selected to check the face validity while test blue print check the content validity. The reliability index of the Biology Interest Scale was determined using Cronbach Alpha which gave an index of 0.79. The data collected for this study were analyzed using mean and standard deviation to answer the research questions while the four hypotheses were tested at 0.05 level of significance using ANCOVA. The results revealed that students taught Biology using Process Oriented Guided Inquiry Learning gain higher mean interest scores than those taught using conventional method. There were no differences in the mean interest scores of both male and female students taught Biology using Process Oriented Guided Inquiry Learning. It is recommended that Biology teachers should be encouraged to incorporate Process Oriented Guided Inquiry Learning (POGIL) as it allows students to actively participate in learning activities and promotes their success in Biology.

KEYWORDS: Process Guided Inquiry learning. Student Interest, Senior Secondary Schools, Biology

I. INTRODUCTION

Scientific literacy is a major gateway to achieving scientific and technological advancement and economic survival. One of the ways for achieving this scientific literacy is through science education. Science Education, specifically science and technology contribute immensely to academic achievement and development, as seen in teaching and learning process. Science Education also helps to improve the social, economic, political and the entire lifestyle of mankind. (Manu & Mohammed, 2020). Scientific literacy relates to the ability to think scientifically and use scientific knowledge and process to both understand the world around us and participate in decisions that affect it. Increasingly, Science and Technology shape our lives. If science and technology will be sustained and promoted, then science education should be seen and taken as a major investment. Alebiosu (2013) asserted that science and Technology aim at the provision of the necessity of life so as to make life and living more comfortable. Biology is a science subject being taught at the senior secondary school (Danladi, 2020). The subject seems to be the most well-known science subject at this level. Biology teaching helps learners to

understand biological concepts, principles, theories and laws. Nwosu (2016) referred to biology as a science of life that is offered in all senior secondary schools in Nigeria which attract the greatest patronage of both sciences oriented and Art based students. Hence any students whose courses or career in science and applied science are determined by how students' performance in biology at the senior secondary school certificate examination (SSCE) level. For instance, a student who is deficient in biology could hardly be admitted to study science related courses as medicine, nursing and pharmacy in the university. Despite the fact that biology is the simplest to comprehend among the science subjects, the level of academic achievement is nonetheless not much different from other science subjects among the students. According to Akubuilu (2014); Dajal and Mohammed (2019), Akinwumi and Falemu (2020), this failure rate could be attributed to the teaching method adopted by the teachers which is usually conventional method and this conventional method does not anyway increase students' achievement the subject. Teaching method adopted by teacher at all level of education in impacting knowledge and skill to the learners are determined by the teacher's abilities, topic to be taught, learner's age and available resources (Atadoga & Onaolapo, 2018). From all these observations, it becomes imperative for the researcher to experiment an inquiry learning that can enhance meaningful learning of concept in biology and hence prevent poor performance. One of such method is the process oriented guided inquiry learning.

Process Oriented Guided Inquiry Learning (POGIL) is described as a student- centred philosophy and science pedagogy in which students work in a small group to engage guided inquiry using carefully designed materials that direct and guided them to generate and construct their biology knowledge. Process oriented guided inquiry learning (POGIL) is one of the learning model which is based on constructivist theory (Zamista, 2015). Hamson (2013) affirmed that process oriented guided inquiry learning emphasizes cooperative learning; during the learning process, students work in teams, design activities to build and developed cognitive skill, such as sciences process, thinking skills, problem solving, communication skills, managements positive social attitude building and self-assessment skills which can develop metacognitive knowledge. Simonson and Shadle (2013) opined that process oriented guided inquiry learning use specially designed activities and cooperation learning to teach content and to actively engage students in inquiry, analytical thinking and teamwork. According to Habib (2017) process oriented guided inquiry learning is a learning model that combine the guided inquiry and cooperative approach that can improve performance value and stated that students and teacher found the classroom environments more pleasant. Rohmah (2013) also submitted that the process oriented guided inquiry learning can be used to enhance students critical thinking skills. In addition, process oriented guided inquiry learning (POGIL) is a structural approach that requires students to work in self-managed team to explore content in a manner that require them to solve problem, conduct analysis and cooperate to draw valid conclusion. Straumanis (2010) point out that POGIL involves stage that require students to think, meaning they must have the confidence to follow the learning well. Example of such stages are: exploration, concept invention/formation and application. In process oriented guided inquiry learning (POGIL) setting, teacher presents an issues to build cognitive conflict in students in order to motivate them to solve problem and designed activities under the teacher's guidance. These activities will enable the students to acquire the concept of knowledge and develop various skills.

In a study conducted by Barthlow and Watson (2014) on effects of Process Oriented Guided Inquiry Learning (POGIL) method of teaching to reduce alternative conceptions about the nature matter held by high secondary school students. The quasi experimental, pre-test, post-test, non-equivalent control group design was adopted. The two researchers compared the impact of Process Oriented Guided Inquiry Learning (POGIL) strategy versus the conventional teacher based teaching using pre-test, post-test design and the results of this study revealed that learners who taught through POGIL activities had fewer alternative conception about the nature of matter. The result of the analysis showed that the performance in the post-test of both male and female learners in their study was equally rated. In another study by Kaundjwa (2015) on influence of Process Oriented Guided Inquiry Learning (POGIL) on science foundation students' achievement in stoichiometry versus traditional lecture centred pedagogy in South Africa. A quasi-experimental non-randomized pre-test, post-test control group design was used to investigate the achievement in stoichiometry. Two intact science foundation class groups at the University of Namibia were used as a case study. Data on student achievements were collected and analysed using descriptive statistics and Analysis of Covariance (ANCOVA). The ANCOVA result was discovered that there was a significant statistical difference in achievements when comparing the

adjusted mean score (54.5%) obtained by the control group and the adjusted mean score (60.5%) obtained by students in the POGIL group. The POGIL group also showed the highest average improvement (65%) on questions related to reaction stoichiometry and limiting reagents, whereas the control group recorded improvement of about 53% in the same section. In another study conducted by Yilmaz and Geban (2015) on effects of Process Oriented Guided Inquiry Learning (POGIL) method compared to traditional designed chemistry instruction method on 11th grade students' self-regulated learning skills in Turkey. Quasi experimental of non-equivalent control group design was used. The study was carried out in two randomly selected intact classes. Two experimental groups and two control groups were randomly selected. Participants were one hundred and fifteen (115) students from high school in Turkey. Experimental groups were instructed with POGIL, while the control groups receive traditional designed chemistry instruction. The results revealed that POGIL improved students' mastery approach task value, control of learning beliefs, self-efficacy for learning and performance, critical thinking, help seeking, peer learning. Based on the findings, results showed that POGIL was superior to the traditionally designed chemistry instruction on students' self-regulated learning skills. It is therefore based on this that the study was designed to investigate the effects of process oriented guided inquiry learning (POGIL) on biology student's interest and achievement in senior secondary schools. Specifically, the objectives of the study were to; find out the difference between mean interests of students taught Biology using process oriented guided inquiry learning and those taught using conventional method; determine the difference between mean achievement scores of students taught Biology using process oriented guided inquiry learning and those taught using conventional method.

II. METHODOLOGY

The research design for the study was quasi-experimental design. Specifically, the study applied pre-test, post-test, non-randomized control group. This is because intact classes were used so as not to disturb the normal setting of the schools' lessons. The pre-test was used to establish the equivalence of the two groups. The population of this study was 25,125 SS II Biology students in senior secondary schools in Federal Capital Territory Abuja. A sample size of one hundred and two (102) biology students were used as sample for the study; multi-stage sampling procedure was adopted. At the first stage of sampling, simple random sampling method was used to select one (1) area council out six (6) area council. At the second stage of sampling, two (2) co-educational secondary schools were purposively selected. This is because they are co-educational, have large population and biology laboratories. One of the schools was labelled experimental while the second school was labelled control group. At the third stage of sampling, simple random sampling method was used in selecting one intact class of biology students from the two sampled schools selected and finally the two classes were assigned to control group and experimental group by tossing a coin. The research instruments used for data collection in this study were; Biology Interest Scale (BIS) and Biology Achievement Test. The Biology Interest Scale (BIS) was used for interest testing before and after the treatment. The Biology Interest Scale (BIS) had two sections, section A and section B. Section A sought response on students' personal data such as sex, age while section B consists of a modified 4 point Likert scale responses that is Strongly Agree(SA), Agree(A), Disagree (D) and Strongly Disagree (SD) on students' interest towards Biology learning. The instrument consists of twenty (20) items. The students were requested to indicate their preference in agreement with the rating. Each item was rated in the 4 points Likert scale as follows: Strongly Agree (SA) =4, Agree (A)=3, Disagree (D)=2, Strongly Disagree (SD)=1 for positive statement while for negative statement it was arranged as follows; Strongly Agree (SA) =1, Agree (A)=2, Disagree (D)=3, Strongly Disagree (SD)=4. The instruments BIS was subjected to both face and content validity. Biology Achievement Test (BAT) was used for both pre-test achievement scores, post-test achievement scores. It comprised of twenty-five (25) multiple choice items with four (4) options, lettered A-D. Each item Biology Achievement Test (BAT) carried 1 mark. The test items were based on the topics Regulation of internal environment, Mammalian skin, Central nervous system, Peripheral nervous system, function of neuron and Ecology of population. The original test consisted of 30 items but 25 items survived validation. In constructing BAT, the researcher prepared a table of specification (Test Blue Print) to guide the test development. In accordance with Senior Secondary School Curriculum. The validation of these instruments was done by two experts from the Department of Science and Environmental Education, University of Abuja to check the face validity while table of

specification was used for content validity of the instrument. Some corrections were made in the BIS by these experts and it was effected in the final copies of the instruments. After the validation, the BIS was subjected to pilot test in which one intact class consisting of 30 SSII Biology students was used. The reliability coefficient of the instrument was determine using Cronbach Alpha which gave 0.79. This indicated that the items were reliable within the acceptable limits. The BIS Pre-test and post-test was administered by the researcher and two research assistants and the scores obtained was used as data for this study. The data collected for the study were analysed using descriptive statistics of frequency count, means scores and standard deviation to analyse the demographic variables of respondents and also answer the research questions, while inferential statistics of ANCOVA at 0.05 level of significance was used to test the null hypotheses. The analysis was computer based, with the use of the Statistical Packages for Social Science (SPSS), version 21.

Research Questions

The following research questions were raised to guide the study;

- What is the difference between mean interest scores of students taught Biology using process oriented guided inquiry learning and those taught using conventional lecture method?
- What is the difference between mean achievement scores of students taught Biology using process oriented guided inquiry learning and those taught using conventional lecture method?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance;

HO₁: There is no significant difference between the mean interest scores of Biology students exposed to Process Oriented Guided Inquiry Learning method and their counterparts taught to conventional lecture method.

HO₂: There is no significant difference between the mean achievement scores of Biology students exposed to Process Oriented Guided Inquiry Learning method and their counterparts taught to conventional lecture method.

III. RESULTS AND DISCUSSION

Research Question One: What is the difference in the mean interest scores of biology students taught using process oriented guided inquiry learning and those taught using conventional method?

Table 1: Mean and Standard Deviations on Post Test Interest Scores for Experimental and Control Groups

Group	Number	Mean	Std	Mean Diff
Experimental	48	3.93	0.42	0.42
Control	54	3.51	0.31	
Total	102			

Table 1 shows the mean and standard deviation on interest scores of students who were taught biology using POGIL and conventional method. The result revealed that student in experimental group had a mean score of 3.93 and standard deviation as 0.42 while control group had a mean score 3.51 and standard deviation of 0.31. The mean difference between the experimental group and the control group was 0.42 in favour of the experimental group. This means that students who were taught biology using POGIL in the experimental group gained higher interest score than their counterparts taught using conventional method in the control group.

Research Question Two: What is the difference in the mean achievement scores on Biology students taught using Process Oriented Guided Inquiry Learning (POGIL) differ from their counterparts in the control group?

Table 2: Mean and Standard Deviations on Mean Achievement Scores between the Experimental and the Control Groups

Group	Number	Mean	Std	Mean Diff
Experimental	48	19.60	1.49	
Control	54	16.59	1.89	
Total	102			3.01

Table 2 shows the mean achievement scores of experimental and the control groups in respect to difference in students' achievement. The table further revealed that student in experimental group had a mean achievement score of 19.60 and standard deviation of 1.49 while control group had a mean achievement score of 16.59 and standard deviation of 1.89. The mean difference between the experimental group and the control group was 3.01 in favour of the experimental group. This means that students in the experimental group had higher achievement scores than their counterparts in the control group.

Test of Hypotheses

H₀₁: There is no significant difference between the mean interest scores of biology students exposed to Process Oriented Guided Inquiry Learning and their counterparts taught in the control group.

Table 3: One Way Analysis of Covariance (ANCOVA) Mean of Interest Scores for Experimental and Control Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
BIS pre	1.859	1	1.859	16.026	.000	.139
Group	4.363	1	4.363	37.616	.000	.275
Error	11.482	99	.116			
Total	1419.470	102				
Corrected Total	17.905	101				

a. R Squared = .359 (Adjusted R Squared = .346)

Table 3 shows the summary one-way ANCOVA on mean interest scores of students taught Biology using process-oriented guided inquiry learning and those taught using conventional method. The results of the analysis show that ($F(1, 101) = 37.616$, where $p = 0.000 < 0.005$). Hence, the null hypothesis was rejected. This means that there was statistically significant difference in mean interest scores between students taught Biology using process-oriented guided inquiry learning and those taught using conventional method in favour of students in experimental group.

Table 4: One Way Analysis of Covariance (ANCOVA) Post Test Mean of Achievement Scores for Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
BAT pre	5.440	1	5.440	1.863	.175	.018
Group	219.103	1	219.103	75.036	.000	.431
Error	289.076	99	2.920			
Total	33609.000	102				
Corrected Total	524.990	101				

Table 3 shows the summary one-way ANCOVA on mean interest scores of students taught Biology using process-oriented guided inquiry learning and those taught using conventional method. The results of the analysis show that $F(1, 101) = 75.036$, where $p = 0.000 < 0.005$). Hence, the null hypothesis was rejected. This means that there was statistically significant difference in mean achievement scores

between students taught Biology using process-oriented guided inquiry learning and those taught using conventional method in favour of students in experimental group.

The findings of results from the research question one and null hypothesis one revealed a significant difference in mean interest scores between the experimental and the control group. That is, students exposed to process oriented guided inquiry learning approach is to be effective in improving student's interest to Biology concepts in Senior Secondary Schools. The finding emanating from this study are in agreement with the findings of Yunusa, Abdulwahi and Abdullai (2014) who indicated that students in experimental group taught using cooperative learning had more interest in Biology and performed better than those not exposed to conventional lecture method. The reason for these similarities may be attributed to the fact that students were active involved and interact between students and teachers, between students and learning environment as well as process oriented guided inquiry learning of knowledge by the students in the experimental group. This may have boosted the interest of students in the experimental group because there is internal satisfaction derived from guided inquiry learning by oneself. The low interest scores as found among the students taught with conventional method may not be unconnected with the fact that they were not actively involved in the teaching-learning process which hinders process oriented guided inquiry learning approach. The implication for tis findings could provide opportunity for students to engage in critical thinking and problem solving, as well as stimulate their desire to learn and stimulate their interest towards Biology.

The findings from the analysis indicated that the mean achievement score of students in the experimental group is significantly higher than those in the control group. Hence, the experimental group had better achievement than the control group. These findings have agreed with the findings of Kaundjwa (2015) which shows that mean pre-test scores of the experimental and control groups used for the study are insignificant while the mean post-test scores showed a wide difference as indicated by a mean of 60.5% implying that there is a significant difference between the achievement scores of students taught with process oriented guided inquiry learning and those taught with lecture method in favour of POGIL. The finding also lend support to the findings of Dajal and Ejezie (2020) who found that students in experimental had higher achievement in Physics taught using guided discovery learning approach than their equivalent in control group taught lecture method. The better achievement of the experimental group over the control group could be as a result of the students' increased interest in Biology. The variations in achievement scores among the groups may be due to the variation in the instructional strategies adopted in each of the groups. This may again have translated into influencing subject's scores in the achievement test.

IV. CONCLUSION

The findings of the study led to the conclusion that the use of process oriented guided inquiry learning approach in teaching and learning Biology appear to be effective than the conventional method. Again, it was concluded that process oriented guided inquiry learning approach if employed by Biology teachers and properly handled, will make Biology lessons interesting, motivate learners to learn and lead to higher academic achievement of Biology concept. Based on the findings, the following recommendations were made: Biology teachers should be encouraged to incorporate process oriented guided inquiry learning of teaching since the method provides the opportunity of engaging students in learning activities and encouraging their performance and interest towards biology concepts. Biology teachers should be trained and retrained on the job to adopt the use of POGIL in the teaching and learning of Biology in the classroom. Training of these teachers could be done by the Government or relevant professional bodies like Science Teachers Association of Nigeria (STAN) through seminars, workshops and conferences. The school authority should provide necessary facilities needed for effective process oriented guided inquiry learning for teaching and learning biology content since the method was found effective boosting student interest in senior secondary schools' level. Biology teachers should try as much as possible to adopt process oriented guided inquiry learning for effective teaching and learning so as to increase interest of male and female students.

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