

## Effect of Investigative Laboratory Approach and Expository Method on Acquisition of Science Process skills by Biology Students of Different Level of Scientific Literacy

Nneka R. Nnorom  
Department of Science Education,  
Chukwuemeka Odumegwu Ojukwu University, Uli.  
nnekannorom@yahoo.com

### Abstract

*The study examined the effect of investigative laboratory approach and expository method on acquisition of science process skills by biology students of different level of scientific literacy in Nnewi North Local Government Area of Anambra state Nigeria. Quasi experimental test, pre-test, post test, non equivalent group design was used for the study. A sample of one hundred and fifty (150) senior secondary one (SSI) biology students randomly drawn from four sampled schools in Nnewi North Local Government Area was need for the study. Three research questions and two null hypotheses guided the study. Two instrument known as Test of Science Process Skills Acquisition (TOSPSA) and Scientific Literacy Test (SLT) were used for data collection. Mean and standard deviation were used to answer the research questions while Analysis of covariance (ANCOVA) were used to test the hypotheses at 0.05 level of significance. Results revealed that students taught using investigative laboratory approach performed better than those taught using the expository method. Also, there was no interaction between the methods and scientific literacy level of biology students on science process skills acquisition. Based on the findings some recommendations were made.*

**Keywords:** Effect, Investigative Laboratory Approach, Expository Method, Science Process Skills, Scientific Literacy, Biology

### INTRODUCTION

Science being a great enterprise which nations depend on to advance technologically is receiving much emphasis in education because of its significance and relevance to life and society. Biology as a branch of science and the prerequisite subject for many fields of learning contributes immensely to the technological growth of the nation; this includes medicine, forestry, biotechnology and nursing. Science teachers should be aware of certain general rules, which facilitate the selection of appropriate approach of impacting knowledge or developing a particular skill to pupils. Several research reports indicate that students achieve poorly in secondary school science subjects (Azubike, 2005; Nwagbo, 2001; Anyagh & Okwu 2010, and Okoli, 2006).

Also, the West Africa Examination Council Chief Examiner Report (2011) revealed that although biology has the highest enrollment relative to other science subjects, it records a very poor performance at Senior School Certificate Examinations especially in the practical examination where students exhibit very poor science skill acquisition. 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 rejecting the practical activity method which enhance teaching and learning. This negligence and “shy away” attitude from activity-oriented method of teaching is not in keeping with the aims and objective of education in Nigeria which state that: “education should aim at helping the child acquire appropriate skills, and competence, both mental and physical as equipment for the individual to live in and contribute to the development of his society (Federal Ministry of Education (FME), 2008). A number of factors have been identified as contributing to non acquisition of skills by secondary school students. One of such factors is the teacher variable, that is, the teacher’s method of teaching. Also research reports have shown that many science teachers prefer the traditional expository/lecture method of teaching and avoid innovative activity oriented teaching method such as inquiry, discovery, concept mapping, investigative laboratory approach, cooperative learning (Okebukola, 1985; Ezeliora, 1999; Okoli, 2006; Nwagbo, 2006; Nwagbo and Chukelu, 2011; Okeke and Nkiruka, 2013; Nnorom and Obi, 2013; Nnorom, 2015). Hence, there is need to investigate the effects of the investigative laboratory approach and expository method on science process skill acquisition by biology students of different levels of scientific literacy.

The expository/lecture method is a method of teaching that is centred on the teacher as the controller of the class. It includes those verbal methods in which some authority or experts preset information without overt interaction taking place between the experts and the learners (Nwagbo, 2006). Also, Okoli (2006) noted that expository method is a teaching method in which the teacher presents a

verbal discourse on a particular subject, theme or concept to the learners. It is an ideal way of communicating coherent sequence of ideas and it is used to elaborate, clarify and discuss factual information or views on issues and problems. Teachers use it to deliver preplanned lessons to the students with little or no instructional aids or exposure to laboratory activities.

According to Okeke and Nkiru (2013) the investigative laboratory approach is a method of teaching in which the students are guided to find out the truth of ideas, facts or assumptions for ultimate confirmation or rejection. The rationale for using this approach in science teaching lies in the fact that if children are fully involved in activities and challenged to come out with results, they are more likely to learn than if they were simply told or presented with outcome of experiments. This method emphasizes knowledge and skill acquisition through hands-on-minds-on scientific activities under the guidance of the science teacher. Students are also provided with the opportunity to interact with the environment through observing, classifying, measuring, questioning, hypothesizing, collecting and interpreting data, accurate reporting, predicting and inferring (Okoli, 2006).

Also, science process skill according to Harlen (1984) are those abilities which can be developed by experience and which are used in carrying out mental operations and physical actions. Science process skills are cognitive and psychomotor skills which scientists employ in problem identification, objective inquiry, data gathering, transformation, interpretation and communication (Okoli, 2006).

Furthermore, studies have shown that when one acquires the science process skills on observing, measuring, designing experiments, interpreting data among others such a person becomes specially equipped with the tools required for scientific inquiry or problem solving as well as ability to use these skills in the laboratory for a variety of investigations, (Ajunwa 2005; Okebukola and Ogunniyi, 1984; Nwosu, 1990; Nwagbo and Chukelu, 2011). Therefore, laboratory skills are synonymous in many ways with science process skills; instructional strategies that enhance the acquisition of laboratory skills.

Scientific literacy is acquisition of scientific knowledge and skills that enable one to live successfully in this modern age of science and technology (Ibe, 2004). It enables one to take the right decisions on scientific issues affecting one's personal and civic life. The foundation for scientific literacy is laid in the secondary school, therefore there is need to investigate its acquisition process.

The persistent poor performance of biology students in West Africa School Certificate Examination with poor science process skills acquisition exhibited in practical examinations leaves one in doubt about the teaching method used by biology teachers. Several authors had reported that the expository method of teaching is popularly used by biology teachers, to teach biology in schools. Then if measures are not taken to improve the poor academic achievement, the hope of producing the right scientists for technological development would not be realized. Therefore, there is need to find out the effects of expository method and investigative laboratory method on acquisition of science process skills by biology students of different level of scientific literacy.

### **Purpose of Study**

The main purpose of this study is to find out the effects of investigative laboratory approach and expository method on acquisition of science process skills by biology students of different level of scientific literacy. Specifically, the study would also find out the interactive effects of teaching methods and scientific literacy levels of biology students on acquisition of science process skills.

### **Research Questions**

The following research questions were formulated to guide the study:

- What is the effect of investigative laboratory approach and expository method on acquisition of science process skills by SSI biology students of different level of scientific literacy?
- How do teaching methods interact with scientific literacy levels of students in acquisition of science process skills?

### **Null Hypothesis**

The following null hypotheses were formulated at 0.5 level of significance:

- There is no statistically significant difference ( $P < 0.05$ ) in the mean score on level of acquisition of science process skills of students of different level of scientific literacy taught biology concepts using investigative laboratory approach and those taught using expository method.
- There is no statistical significant interaction ( $P < 0.05$ ) between teaching method's and scientific literacy level on acquisition of science process skills.

## METHOD

The design of the study was Quasi-Experimental, specifically, pre test, post test, non-equivalent control group design. This design was adopted because intact classes were used as it was not possible to have complete randomization of the subjects. The sample consists of 150 Senior Secondary One (SS1) biology students from four (4) schools randomly selected from Senior Secondary Schools in Nnewi North Local Government Area of Anambra State. Only four schools (two all boys and two all girls) were sampled using stratified and simple random sampling technique due to experimental nature of the study. One all boys and one all girls schools sampled were assigned to the experimental treatment while the other two schools were assigned to the control condition. The experimental sample ( $N = 76$ ) consisted of 37 boys and 39 girls. While the control sample ( $N = 74$ ) consisting of 36 girls and 38 boys. Two instruments were used for data collection namely (a) Test of Science process skills Acquisition (TOSPSA) developed by the researcher based on the biology topics taught: Animal Nutrition, which was from SS1 biology curriculum. The TOSPSA comprised of 25 items test designed to measure the level of acquisition of each science process skill.

TOSPSA was made up of two sections (A and B). Section A was a practical skills test consisting of practical work while section B was of multiple choice type with four options A,B,C,D. The use of the practical questions for assessment in section A was based on preference of practical activities over theory questions. In this section, the students were required to demonstrate behaviours such as making careful and accurate measurements, observation, experiments, classifications, predicting on the basis of the experimental data and inferring. Examples of items on practical skill tests in section A are as follows:

1. Use your ruler to measure the length of specimen "K". Cut it into two equal size and measure the part again.
2. Smear a drop of the mixture 'L' on a piece of white paper, hold the paper against the light and record your observation and inference. Thus:

Test	Observation	Inference
------	-------------	-----------

The TOSPSA test items were validated by two specialists, in science education who are also seasoned science teachers. The reliability of TOSPSA test was determined using split half reliability test and the reliability coefficient was 0.85.

The Scientific Literacy Test (SLT) was a modified scientific literacy test developed by Nwagbo (1997) and consisted of four sections. It was validated and the reliability coefficient for the sections are as follows:

Section A: Knowledge of science concept has K-R-20 reliability index of 0.72

Section B: Application of science concept and principles in problem solving; has alternate form reliability index of 0.74

Section C: Communication in science has alternate form reliability index of 0.91.

Section D: Attitude to science and appreciation of science has cronbathAlpha reliability index of 0.92.

The total score for each student on SLT was collected as percentage and this formed the basis for categorizing students into level of scientific literacy as follows:

70% and above	High level of Scientific Literacy
50% - 69%	Medium level of Scientific Literacy
0% - 49%	Low level of Scientific Literacy

### Experimental Procedure

The regular biology teachers were used for the study in both experimental and control groups. The teachers who participated in the experimental treatment were subjected to rigorous training for a period of two weeks. The teachers underwent training on how to conduct instructions using the investigative laboratory approach to ensure uniformity and mastering of the teaching methods. Also, each of the experimental stream teachers was given a copy of the validated lesson plan and copies of the two instruments (TOSPSA and SLT) which was used for data collection. The teachers in the control group did not receive any training. They were required to teach the selected biology concepts using the conventional expository method of instruction. The researcher vetted the lesson plan prepared by the biology teacher in the control group to ensure that the teacher did not deviate from the procedures of instructions commonly used by biology teachers. Also, each teacher in the control group was given copies of the two instruments

(TOSPSA and SLT) which was used for data collection. The Scientific Literacy Test (SLT) was administered only as pre-test and used for categorizing students into high, medium and low levels of scientific literacy. Test of science process skill acquisition (TOSPSA) was used for both pre test and post test. The treatment consisted of teaching a selected biology concept, Animal Nutrition using the investigative laboratory Approach. This involves exposition of students to practical/laboratory exercises, use of specimen/materials to concretize learning as well as foster students interaction with their environment, the teacher and among themselves. The control group was taught the same biology concepts using expository method. The teacher presented actual information to the students on the biology concepts and in addition gave a verbal explanation of the experiment procedure and the expected results.

The teaching lasted for four weeks of twelve periods. The teacher administered the post test (after reshuffling) of the items to the subjects in the two groups using science process skill acquisition test. The scripts from both pre-test and post test of the two groups were marked and scored using the marking guide.

The data collected from the pre-test and post-test of TOSPSA were analyzed using mean and standard deviation for answering the research questions while Analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05% level of confidence.

## Results

Table 1: Mean and Standard Deviation Scores of students in test of science process skills acquisition due to teaching methods and scientific literacy level.

Teaching method	Type of test	Scientific Literacy Level					
		High		Medium		Low	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Investigative Laboratory Approach	Pre-test	24.07	9.20	23.05	5.61	21.11	11.20
	Post-test	69.25	9.28	57.18	17.16	49.38	11.36
Expository Method	Pre-test	26.18	19.10	21.19	13.38	21.10	13.11
	Post-test	57.16	15.51	51.13	19.02	44.44	13.71

Table 1 shows that the two teaching methods had remarkable effects on the students level of acquisition of science process skills. Students in the high level scientific literacy group exposed to the investigative laboratory approach had higher mean science process skills acquisition score of 69.25 than those in the medium and low level of scientific literacy group scores of 57.18 and 49.38 respectively. While students in the medium level scientific literacy group had higher mean science process skills acquisition score than those in the low level scientific literacy group. From this result, it can be concluded that for the students exposed to the investigative laboratory approach (experimental group), the higher their scientific literacy level, the higher their level of acquisition of science process skills in biology.

In the expository method group, students in the high scientific literacy level group had higher mean science process skills acquisition score of 57.16 than those in the medium and low level scientific literacy groups 51.13 and 44.44 respectively. Also, students in the medium level scientific literacy group had higher mean science process skills acquisition score than those in the medium and low level scientific literacy groups. Also, students in the medium level scientific literacy group had higher mean science process skills acquisition score than those in the low level scientific literacy group. These results revealed that for the students exposed to the expository method of teaching biology, the higher their scientific literacy level, the higher their level of acquisition of science process skills in biology.

Table 2: Adjusted Mean and Standard Deviation Scores of students on science process skills Acquisition in biology due to teaching Methods and scientific literacy level

Teaching method		Scientific Literacy Level		
		High	Medium	Low
Investigative Literacy Approach	N	16	29	31
	$\bar{x}$	25.27	23.41	17.18
	SD	9.42	18.30	10.81
Expository Method	N	26	19	29
	$\bar{x}$	18.21	20.17	11.82
	SD	12.61	10.30	10.61

Table 2 results showed that all levels of scientific literacy students exposed to the investigative laboratory approach recorded higher mean science process skills acquisition scored than those exposed to the expository method of teaching. The results further revealed that there was no interaction between teaching methods and scientific literacy level of acquisition of science process skills in biology. The two hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05% level of confidence.

Table 3: ANCOVA of students science process skills acquisition scores by Teaching Methods and Scientific Literacy Levels

Source	Sum of square	Df	Mean of squares	F	Significance F	Decision
Pre-test	6764.121	1	6764.121	38.127	0.000	
Main effect	3741.043	3	911.028	6.332	0.001	
Teaching Methods	673.764	1	673.764	5.236	0.047	
Scientific Literacy Level	3469.323	2	1725.54	8.252	0.001	
2 way interaction Teaching methods scientific Literary Level	236.637	2	121.850	0.722	0.635	
Explained	10371.045	6	2704.342	21.032	0.000	
Residual	23266.424	136	140.745			
Total	396394.71	142	325.647			

The results for hypothesis one as shown in table 3 revealed that F(5.236) is significance at 0.047 for the teaching methods at 1 and 136 degrees of freedom. This is because 0.047 is less than 0.05 significant level as earlier stated. Hence the null hypothesis was rejected. That is, there is a significant difference in the level of acquisition of science process skills by students of different level of scientific literacy taught biology concept using investigative laboratory approach and those taught the same concept using the expository method.

Also data on table 3 revealed that the main effect scientific literacy level had an F(8.525) at 2 and 136 degrees of freedom and is significant at 0.001. Hence, the null hypothesis was rejected. This implies that there was a significant difference in the mean score on acquisition of science process skills by students of high, medium and low levels of scientific literacy taught biology concepts using the two teaching methods. The result showed that the students taught using the investigative laboratory approach performed better than those taught using the expository method of teaching.

For hypothesis two, result in the table indicated that the 2-way interaction between teaching methods and scientific literacy level is 0.722 at 2 and 136 degrees of freedom and is significant at 0.635. This value is not significant at 0.05 level. Hence the hypothesis is accepted that is, there is no significant interaction between teaching methods and scientific literary level on acquisition of science process skills.

## DISCUSSION

The findings of this study revealed that the investigative laboratory approach enhanced science process skills acquisition in biology among students of different levels of scientific literacy than the expository method. This finding is in agreement with Okoli (2006) and Nwagbo (2001) who found that the investigative laboratory approach and guided inquiry methods of teaching biology enhanced achievement better than the expository method among biology students of different scientific literacy levels.

Also, the result of this study in table 1 revealed that the investigative laboratory approach produced the highest mean of science process skills acquisition score in biology for the high level scientific group followed by the medium and low level groups. Also, the expository method produced the highest mean science process skills acquisition score in biology for the high level group followed by the medium and low level groups. This result is in line with Okoli (2006) who indicated that the investigative laboratory approach produced the highest mean science process skill acquisition score in biology for the highest level scientific literacy group followed by medium and low level group.

Furthermore, it was confirmed by ANCOVA result that there is a significant difference in the mean science process skills acquisition score in biology among students in the high, medium and low levels of scientific literacy. The findings revealed that the higher the scientific literacy level of the students, the better their science process skills acquisition in biology for the two teaching methods. This result is in consistent with the findings of Nwagbo (1977); Okoli (2006); Nwagbo and Chukelu (2011)

who investigated on the effect of teaching methods on acquisition of science process skills among students of different levels of scientific literacy. The result also revealed that there was no interaction between teaching methods and scientific literacy level on acquisition of science process skills in biology. This result confirms with the findings of Nwagbo (2001) and Okoli (2006) who found no interaction between teaching methods and scientific literacy level of achievement in biology by students of different level of scientific literacy.

The findings of this study revealed that teaching students using the investigative laboratory approach enables students to acquire science process skills and to participate actively in the class. This is because as the students participate and manipulate equipment, they apply their five senses and other skills to their lessons more than when they would have remained less active in the class.

The findings of this study have implications on the teacher who should adopt investigative laboratory approach of teaching which is the student centred method. Students learn better when they are involved in classroom activities. Activity-based method enhance and increase the ability to acquire science process skills by the learner.

### CONCLUSION

Based on the findings, the study revealed that use of an investigative laboratory approach for teaching biology concepts to students at different levels enabled them to acquire science process skills better than using expository method of teaching. There was no interaction effects of scientific levels and teaching methods on biology students acquisition of science process skills.

### RECOMMENDATIONS

Therefore, the following recommendations were made:

- Teachers should encourage students to develop interest in laboratory activities by engaging them in practical, being creative, resourceful and enthusiastic in their chosen profession, and also inculcating scientific literacy in those students.
- Government should provide conducive learning environment by equipping biology laboratory and adequate classroom to enhance science process skills acquisition by students.
- Ministry of Education and professional organization like STAN should organize workshops, seminar and conferences for biology teachers.
- Science educators and curriculum planners should incorporate innovative pedagogical strategies like investigative laboratory approach into their various teacher education programme.

### REFERENCES

- Ajunwa, C. A. (2005). Acquisition of physics process skills by secondary school students. *Unpublished Ph.D thesis. Department of Science Education, University of Nigeria, Nsukka.*
- Anyagh, P. I. & Okwu, E. I. (2010). Effect of formula teaching approach on students' achievement in Algebra. *Journal of Research in Curriculum and Teaching* 5(1) 374 – 379.
- Azubuike, A.S. (2005). Inquiry and problem solving approach. *Integrated science Education Series of science Teachers Association of Nigeria*, 2, 20-26.
- Federal Republic of Nigeria (2008). *National policy on education*. Lagos: NERDC Press
- Harden, W. (1984). *The training of primary Educators: A workshop approach* Paris: UNESCO Science and Technology Document Series No. 13.
- Ibe, E. (2004). Effect of guided inquiry, demonstration and conventional methods of teaching science on acquisition of science process skills among secondary school students. *An unpublished M.ed thesis. Department of science education, University of Nigeria, Nsukka.*
- Nnorom, N.R. & Obi, Z. (2013). Effects of practical activities on achievement in biology among secondary school students in Anambra state. *ANSU Journal of Education Research*, 1(1) 89-94.
- Nnorom, N.R. (2015). Effect of cueing question as instructional scaffolding on students achievement in biology in Ogidi Education zone of Anambra state. *American Academic & Scholarly Research Journal* 7(6), 21-30.
- Nwagbo, C. & Chukelu, U.C. (2011). Effects of biology practical activities on students process skill acquisition. *Journal of Science Teachers Association of Nigeria* 46(1) 58-70.
- Nwagbo, C.R (2001). The relative efficacy of guided inquiry and expository methods on achievement in Biology of Students of different levels of Scientific Literacy. *Journal of Science Teachers Association of Nigeria*. 36(172) 43-51
- Nwagbo, C.R (2006). Effects of two teaching methods on the achievement in and attitude to Biology students of different level of scientific Literacy. *International Journal of Educational Research*, (45) 216 -229
- Nwagbo, C.R. (1997). Innovations in science teaching: Categorization of students into levels of scientific literacy for effective instructional purposes in .A. Olarewogu (ed). *Innovations Science, Technology and Mathematics (STM) STAN 40<sup>th</sup> Annual Conference Proceeding* 106 – 109
- Nwosu, A.A. (1991). Acquisition of science process skills by students of different cognitive levels: The effects of a teacher sensitization programme. *Review of Education*, 13, 155-166
- Obiekwe, C.L. (2008). Effects of constructivist instructional approach on students achievement and interest in basic ecological concepts in Biology. *Unpublished M.Ed Thesis. University of Nigeria Nsukka.*
- Obiekwe, C.L. (2008). Effects of constructivist instructional approach on students achievement & interest in basic ecological concepts in biology. *Unpublished M.Ed Thesis Dept. of Science Education, University of Nigeria, Nsukka.*

- Okebukola, P.A.O (1985). Levels of process skills development among students and implication for science in Nigeria. *STAN 26<sup>th</sup> Annual Conference Proceeding*. 121-125. Ibadan. Heireman Publishing.
- Okebukola, P.A.O. &Ogunniyi, M.B. (1984). Cooperative and individualistic laboratory interaction pattern: Effect on students achievement and acquisition of practical skills in science. *Journal of Research in Science Teaching* 2(9) 875 -884.
- Okeke, C.M. &Nkiruka, C. (2013). Effect of Laboratory approach and expository method on acquisition of biology process skills in Onitsha Education zone of Anambra State. *Unpublished B.Sc Thesis University of Nigeria, Nsukka*.
- Okoli, J.N. (2006). Effects of investigative laboratory approach and expository method on acquisition of science process status by biology students of different levels of scientific literacy. *Journal of STAN*, 41 (1&2), 79-85.
- West Africa Examination Council (2011). *Chief Examiner Report-on Biology*. Lagos: WAEC