



## Effects of Project-Based Learning Method on Students' Acquisition of Science Process -Skills in Awka Education Zone.

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### Abstract

The study investigated the effect of project-based learning method on biology students' acquisition of science process skills in Awka Education Zone. The design of the study was quasi-experimental design of pretest, posttest non-equivalent control group design. The sample consisted of 284 (SS)II biology students. The instrument used was science process skill acquisition test (SPSAT) for Data Collection. The reliability co-efficients obtained was 0.78 for SPSAT using Kuder Richardson 20 (KR-20) formula. The data collected were analysed using mean and standard deviation for the research questions and analysis of covariance (ANCOVA) at 0.05 level of significance for the hypotheses. The results revealed that the use of the PBL method had a significant effect on students' acquisition of SPS. It also revealed that gender was not a significant factor in students' acquisition of SPS in biology. It was recommended among others that biology teachers should use project-based learning method (PBL) in teaching both male and female students to enhance their acquisition of science process skills in biology.

**Keywords:** Biology, Gender, Project-Based Learning (PBL) Method, Science Process Skills (SPS)

### Introduction

In a highly dynamic world, every person is expected to be equipped with useful skills to fulfill the global demand posed by science and technology. These skills include among others the ability of an individual to observe, predict, formulate, hypothesize, determine and control variables. Thus, teaching methods that can help students to understand and explore scientific phenomena, discuss scientifically, construct cognitive structures, develop skills and improve in problem-solving are needed (Duran & Dokme, 2016). The impact of students' acquisition of these basic skills is that it helps them to develop the 21<sup>st</sup>-century skills which include collaboration and teamwork, creativity and imagination, critical thinking, and problem-solving. Thus, the definition of student's achievements must be broadened to include the 21<sup>st</sup>-century skills that will be required for students to thrive in

the future (PuniaTuriman, Jizah Omar, Adzliana MohdDaud & Kamisah Osman, 2012).

Science process skills provide the learner with the scientific backbone to understand science. Ewers (2001) reports that if science process skills are not acquired, students may be unable to acquire science literacy since science literacy is not limited to reading and hearing instead it requires efficient use of science process skills. Science process skills therefore, comprise the fundamentals of science and thus an important tool in achieving scientific goals. According to Abungu, Okere & Wachanga (2014), science process skills (SPS) are central to the acquisition of scientific knowledge which is useful in solving problems in our society. Hill (2011) defined SPS as the underlying skills and premises which govern the scientific method. In other words, SPS are used to gather information about nature.



Bajah (2011) understood these process skills to be tools which scientists use to do science and that if children are properly introduced early to science through process skills acquisition, they will find the skills useful throughout life. He contends further that it is possible to easily forget science content(s) learnt but process skills learnt tend to remain with individuals for a longer period.

SPS is grouped into two major types- basic and integrated (Padilla, 2011). Ekon and Eni (2015) opined that the integrated SPS are more complex, meant for solving problems in science subjects but the basic SPS provide a foundation for learning the integrated skills. They further stated that there are six (6) basic science process skills, namely: observing, communicating, classifying, measuring, inferring, predicting, and that the integrated science process skills are six, namely: controlling variables, defining operationally, formulating hypotheses, interpreting data, experimenting, formulating models. This research is limited to basic science process skills.

Students' acquisition of science process skills is determined by the teacher, but other factors such as teaching methods employed in the teaching of concepts, teacher's pedagogical content knowledge, availability of teaching resources and classroom management are crucial. Students' acquisition of SPS, is also related to their academic achievement. When students are active in learning, they tend to acquire science process skills and achieve better. Given the recognized association between students' acquisition of science process skills and academic achievement and the crucial need to promote depth of understanding, teachers have thrived to maintain good classroom management and develop teaching methods to augment or supplement the conventional method of

teaching (Armbruster, Patel, Johnson & Weiss, 2009; Smith, Stewart, Shields, Hayes-Klosteridis, Robinson & Yuan, 2005).

The use of conventional methods to convey information to learners has been described by Liu & Long (2014), as teacher-centred, curbs the personality and creativity of students, discourages main experience or subjective experience which restricts students' acquisition of SPS. The conventional methods are teaching methods used by teachers to impart knowledge to students: It includes among others, the lecture method, descriptive method of teaching, demonstration, storytelling, and dictation method of teaching. These conventional methods are important for acquiring fundamental knowledge. However, they are not enough to foster the acquisition of science process skills, necessary to face real-world problems (Blair, Schwartz, Biswas & Lawong, 2007). The conventional methods that will be used as control methods in this research work are the lecture and demonstration methods of teaching.

The lecture method consists of an oral reading of a text followed by a commentary (Kaur, 2011). It is often used to teach organized bodies of knowledge which is an important part of the school curriculum at all levels, and has continued to be a primary form of instruction in colleges and universities even at different school stages (Kaur, 2011). The lecture method helps the teacher to present information and ideas in a short time. It helps the teacher to introduce topics and summarize the main points of the learning activity. Sometimes, during the teaching of topics such as skeleton with the lecture method, the teacher also employs the demonstration method. The demonstration method is a method of providing lessons by exhibiting and demonstrating. The demonstration method is a method of



teaching by demonstrating things, events, rules, and sequences of activities, either directly or through using instructional media which is relevant to the subject matter or material that will be presented (Ramadhan & Surya, 2017). These methods are teacher-centred and students are passive rather than active learners. In these methods, memorization, learning by imitation, and learning by modeling are imminent.

With the aforementioned needs for student's active participation during learning, and the importance of adopting innovative methods of teaching science, education scholars have invented numerous innovative methods to encourage student's active learning and increased achievement. These methods include experiential learning, use of thematic approach, use of graphic organizers, guided discovery and project-based learning (PBL). This research tends to find out the effects of one of these innovative methods known as project-based learning (PBL) on biology student's acquisition of SPS.

PBL is a form of constructivism and collaborative learning with a student-centered learning process (Whatley, 2012). PBL encourages active learning. Chiang and Lee (2016) defined PBL as a process, in which knowledge is constructed through the transformation of experience. In addition, students can observe and analyze problems to construct more meaningful knowledge. Bilgin, Karakuyu and Ay (2015) and Hung, Hwang and Huang (2012) stated that PBL is a research-based method to find solutions to daily life problems. In this method, students take responsibility for working independently and cooperating with others, improving investigative skills, solving their problems, and obtaining final product outcomes. Habok and Nagy (2016) found that PBL has the ability to develop and manage group

dynamics, to assist them in building confidence, and to practice teamwork skills.

In PBL, students search for solutions to a problem by posing and refining questions and discussing ideas, collecting and analyzing data, drawing conclusions, and presenting the findings to each other's (Zimmerman, 2010). In other words, project-based learning is defined as an important method that can aid students to acquire metacognitive strategies, gain the necessary knowledge, basic skills, and scientific attitudes. In this research work, PBL will be used to teach biology students.

Biology is very important for national development because it is the root subject for many careers in science and technology such as medicine, engineering, forestry, agriculture, biotechnology, nursing among others; and has application nearly in every field of life. Students' engagement in studying biology encourages the acquisition of science process skills and better scientific understanding (Karamustafaoglu, 2011).

Students' acquisition of science process skills has often been associated with their gender. Ezeh (2013) explains that 'gender describes the personality traits, attitudes, behaviours, values, relative power, influence, roles and expectation (femininity and masculinity) that society ascribes to the two sexes on a differential basis'. The gender gap in education in favour of girls is a widely known phenomenon. According to (Lietaert, Roorda, Laevers, Verschoren & Fraine, 2015) boys generally have higher dropout rates, obtain lower grades, and show lower acquisition of skills and therefore reported lower support from their teacher. The influence of gender on students' acquisition of science process skills is an important gap the researcher intends to fill.

It is therefore pertinent to state that despite the various effort by government, various



agencies, professional bodies to emphasise students mastering of science process skills because of its central role in nations development and solution to scientific problem; there is still non-acquisition of science process skill (Nwosu & Obialor, 2017); and students may pass through their secondary school without acquiring enough scientific process such as observing, classifying, measuring, experimenting, manipulating, and hypothesizing (Obialor, 2016). Students' academic achievement and their acquisition of science process skills are interlinked, students may achieve better if they acquire skills. Therefore, students' acquisition of SPS is a serious concern to teachers and other stakeholders.

Considering the importance of an innovative and active teaching method on students learning, and the need for the acquisition of science process skills to the nation and the world at large, to achieve better in sciences, the researcher seeks to determine the effect of PBL on acquisition of science process skill of biology students in Awka Education Zone of Anambra State. She further investigated the effect of PBL on male and female students' acquisition of SPS.

A lot of social vices (such as cult clashes) in this zone by secondary school students led the researcher to think of innovative ways of teaching these students to enforce academic engagement and acquisition of science process skills and in the long run achievement in sciences and a better society.

### **Statement of the Problem**

For students to achieve higher in biology, they need to acquire science process skills. Student's inability to acquire skills has been attributed to several factors which includes non-effective methods of teaching concepts, this is because some of the conventional ways of teaching biology in some Nigerian

public secondary schools are teacher-centered approach. These methods sometimes involve repetition and memorization of previously taught material by filling the students' minds with the knowledge of science without explaining in detail the process of analyzing, evaluating, and arriving at a conclusion. In addition, these processes may not make the students acquire science process skills and finally achieve better in biology, because some of them might find it difficult to apply the knowledge acquired through conventional teaching methods to solve scientific problems in a new situation.

Furthermore, from the review of previous studies on PBL, it is noted that there is no study on the effects of Project-based learning on students' acquisition of science process skills in biology in Awka Education zone of Anambra State. The researcher therefore, seeks to find the effects of this innovative teaching method on student's acquisition of science process skills in biology in Awka Education zone of Anambra State.

### **Purpose of the Study**

The main purpose of the study is to determine the effects of project-based learning on senior secondary school students' acquisition of science process skills in the learning of biology. Specifically, the study determined;

1. The mean science process skills acquisition scores of students taught biology using project-based learning (PBL) and those taught using the lecture with demonstration method.
2. The mean science process skills acquisition scores of male and female students in biology.
3. Interaction effect of teaching methods and gender on the mean science process



skills acquisition scores of students' in biology.

### Research Questions

1. What are the mean science process skills acquisition scores of students taught biology using project-based learning (PBL) and those taught using the lecture with demonstration method (LDM)?
2. What are the mean science process skills acquisition scores of male and female students in biology?

### Hypotheses

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

1. There is no significant difference in the mean science process skills acquisition scores of students taught biology using project-based learning (PBL) and those taught using the lecture with demonstration method.
2. There is no significant difference in the mean science process skills acquisition scores of male and female students in biology.
3. There is no significant interaction effect of teaching methods and gender on the mean science process skills acquisition scores students' in biology.

### Method

The design that was adopted for this study is quasi-experimental design. Specifically, the study adopted pre-test, posttest non-equivalent control group design. This design entails the use of non-randomized groups known as intact class. The total population of all year two students in co-educational secondary schools in Awka Education Zone is 2697, made up of 1243 males and 1454 females. The decision to use SSII students is based on having done some

lessons in vertebrates in the SSII class, they are better equipped to undergo projects in skeletal system which the Project based learning method demands. The sample for this study consisted of 284 SSII students (122 males and 162 females) drawn from two co-educational secondary schools out of the 1255 SSII students (541 males and 714 females) in the 15 co-educational public secondary schools in Awka South Local Government Area in the zone. Awka south local government area was selected from Awka Education zone.

The multi-stage sampling procedure was used. These stages include using simple random sampling (balloting with replacement) in selecting one Local Government Area (Awka south local government area) out of the five LGAs in Awka Education zone. Purposive sampling technique was used in selecting 6 out of 15 co-educational schools in the area. The reason for the choice of purposive sampling technique was because the researcher needed schools that will be easily located by her; and with at least two streams of SSII classes. The reason for choice of co-educational school is because gender is a variable in the study. The names of the 6 schools were written on a small piece of paper and folded and the researcher picked two pieces. Using flip of the coin method, one of two schools was assigned as the experimental group and the other became the control group. Finally, in each school, all the arms of the SSII class were listed on pieces of paper and folded. Using balloting with replacement, the researcher picked one piece for each school which represents the intact classes to be used. Arm A was picked in the control group school while Arm B was picked for the experimental group. The experimental group has an intact class of 41 students (12 boys and 29 girls) and the



control group has an intact class of 48 students (13 boys and 35 girls).

The instrument used is the science process skill acquisition test (SPSAT). The SPSAT consists of 25 multiple choice items each with four options, A, B, C, and D. Each of the items in both the SPSAT carries five (4) marks. The test items were developed using biology WAEC past questions based on the contents to be taught in the lesson. The topics taught are (1) skeleton, skeletal materials, (2) types of skeleton (3) bones of the vertebral column, girdles, and long bones of the appendicular skeleton (4) mechanism of support in animals and functions of skeleton. These topics were chosen because they lend themselves to learning by project-based learning and conventional method of instruction, and they are in SS II biology curriculum. The reliability of the SPSAT was determined using Kuder Richardson 20 (KR-20) formula. The items in SPSAT are multiple choice questions that are dichotomously scored. The reliability coefficient of SPSAT was found to be 0.78. The Science Process Skills Achievement Test (SPSAT) was administered on students in both the experimental and control groups by their regular classroom teachers (pre-testing). The

teachers were briefed to avoid giving feedback of the pre-test. The experimental group teacher was trained for three days on how to use the project-based learning method materials including the lesson plan while the classroom teacher for the control group was asked to employ the same teaching strategy she normally uses. The experimental group was taught the same lesson concepts using only the conventional/traditional method of instruction. After five weeks of teaching and the revision period, the same instrument (SPSAT) was reshuffled and re-administered to the same students in their classrooms in the sixth week (Post-testing).

The research questions were answered using mean and standard deviation while the hypotheses were tested using Analysis of covariance (ANCOVA) at 0.05 level of significance.

## Results

1. What are the mean science process skills acquisition scores of students taught biology using project-based learning (PBL) and those taught using the lecture with demonstration method (LDM)?

**Table 1: Mean Pre-test and Posttest Science Process Skills Acquisition Scores of Students taught Biology using Project-based Learning and those taught using lecture with demonstration**

Method	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gain in Mean
PBL	41	21.59	5.96	76.29	5.70	54.70
LDM	48	30.42	7.06	60.98	7.83	30.56
Difference		8.83		15.31		24.14

Table 1 reveals that the students taught biology using PBL had pre-test mean acquisition score of 21.59 and post-test mean acquisition score of 76.29 with gain in mean being 54.70, while those taught using

LDM had pre-test mean score of 30.42 and post-test mean score of 60.98 with mean gain of 30.56. With higher mean gain recorded by the students taught with PBL,





students' acquisition scores in biology was higher than those taught with LDM.

2. What are the mean science process skills acquisition scores of male and female students in biology?

**Table 2: Mean Pre-test and Posttest Science Process Skills Acquisition Scores of Male and Female Students in Biology**

Method	Gender	n	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gain in Mean	Difference in Gain in mean
PBL	Male	12	19.17	6.34	76.33	5.37	57.16	3.47
	Female	29	22.59	5.61	76.28	5.93	53.69	
LDM	Male	12	32.31	6.65	67.23	6.97	34.92	5.97
	Female	35	29.71	7.17	58.66	6.87	28.95	

Table 2 shows that the male students taught biology using PBL has gain in mean science process skills acquisition score of 57.16 while the female has 53.69. The males taught using LDM has gain in mean science process skills acquisition score of 34.92 while the female has 28.95. The difference in gain in mean science process skills acquisition between the male and females taught biology using PBL 3.47 in favour of the males while the

students taught using LDM has 5.97 in favour of the males. The both methods are in favour of the males.

### Testing for Null Hypotheses

**Hypothesis 1:** There is no significant difference between the mean science process skills acquisition scores of students taught biology using project-based learning method (PBL) and those taught using the lecture with demonstration method (LDM)

**Table 3: ANCOVA on Difference between the Mean SPSA scores of students taught biology using PBL and those taught using LDM**

Source	SS	df	Mean Square	F	Sig.	Decision
Corrected Model	5882.543 <sup>a</sup>	4	1470.636	35.413	.000	
Intercept	24293.871	1	24293.871	584.999	.000	
Pretest	.297	1	.297	.007	.933	
Method	2087.122	1	2087.122	50.258	.000	S
Gender	332.735	1	332.735	8.012	.006	S
Method * Gender	314.796	1	314.796	7.580	.007	S
Error	3488.356	84	41.528			
Total	421315.000	89				
Corrected Total	9370.899	88				

Table 3 shows that at 0.05 level of significance, 1df numerator and 88df denominator, the calculated F is 50.258 with Pvalue of .000 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore,

there is a significant difference between the mean science process skills acquisition scores of students taught biology using project-based learning method (PBL) and those



taught using the lecture with demonstration method (LDM) in favour of PBL.

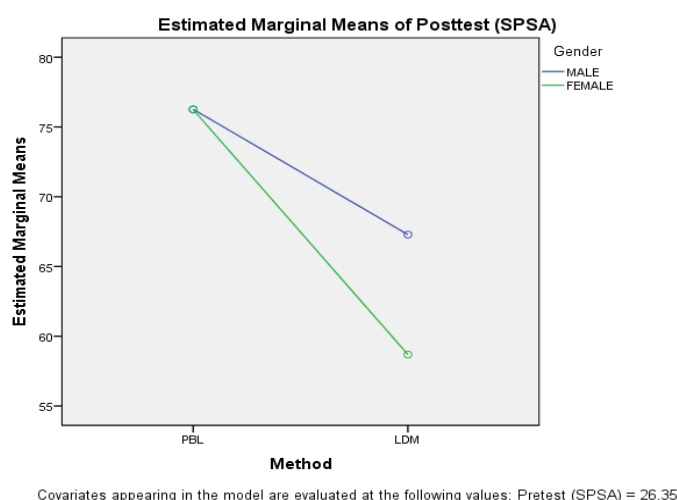
**Hypothesis 2:** There is no significant difference between the mean science process skills acquisition scores of male and female students in biology.

Table 3 also shows that at 0.05 level of significance, 1df numerator and 88df denominator, the calculated F is 8.012 with Pvalue of .006 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is a significant difference between the mean science process skills acquisition scores of male and female students in biology.

**Hypothesis 3:** There is no significant interaction effect of instructional strategies and gender on students' science process skills acquisition.

Data relating to hypothesis 3 is contained in Table 3.

Table 3 further shows that at 0.05 level of significance, 1df numerator and 88df denominator, the calculated F is 7.580 with Pvalue of .007 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is a significant interaction effect of instructional strategies and gender on students' science process skills acquisition. The plot of interaction is shown in Figure 1.



**Figure 1: Plot of significant Interaction between Teaching Strategies and Gender on Students' Mathematics Self-concept**

The plot of the interaction effect between teaching strategies and gender on students' science process skills acquisition is significant and disordinal. Thus, the effect of the instructional strategy on students' science process skills acquisition changes in relation to gender.

### Discussion of Findings

In the learning process of PBL, students need to solve problems by defining the problem, discussing ideas, designing inquires, collecting and analyzing data, and sharing findings with their peers (Bell, 2010). Through their engagement in these activities, they acquire science process skills. Skills are mastered by practice. As students carry out projects, they practice the use of these skills. To effectively carry out a project, students engage their skills of observation, measurement, inference, classification, prediction and communication. The use of these skills in expose students' weaknesses and strength and such feedback help them to acquire more skills.

The finding of the study is in support of the finding of Obialor, Osuafor&Nnadi (2018) that students' project activities had a significant effect on science process skill acquisition in biology. The finding of the study also supports the finding of Hernawati, Amin, Irawati, Indriwati & Aziz (2018) that project-based learning significantly improved pre-service teachers' scientific process skills and self-efficacy. The finding of the study is also in line with the findings of Ika & Srikandi (2018) that the PBL model can improve science process skills and





higher scientific literacy skills compared to groups of students who get conventional learning. The students in the experimental group were able to acquire science process skills through biology concepts more easily than the students in the control group because they were involved in projects and had a first-hand experience with the learning materials. This implies that project-based learning method of teaching improves students' acquisition of science process skills better than the conventional method.

The findings of the study showed that there was a significant influence of gender on science process skills acquisition. Project-based learning that requires more psychomotor skills may be left for male students leading to male students being exposed to learning experiences that enhanced their acquisition of science process skills. This is why there was a significant disordinal interaction effect of instructional strategies and gender on students' science process skills acquisition.

### Conclusion

It can be concluded from the findings of the study that project-based learning is an effective teaching method for enhancing students' acquisition of science process skills irrespective of gender. The use of project-based learning help students to be actively engaged in the learning process, exposing them to learning experiences that aid their acquisition of science process skills.

### Educational Implications of the Study

Empirical data have been provided on the effect of project-based learning method in teaching and learning of biology. The findings of this study reveal that project-based learning method led to a higher acquisition of science process skills by students than the use of the conventional

method. By implication, project-based learning if employed in the teaching of biology at senior secondary school level will enhance students' acquisition of science process skills. This also mean that if this teaching method is employed, there could be an improvement

### Recommendations

In the light of the findings of the study, the following recommendations are made:

1. Biology teachers should adopt the use of project-based learning during biology instructions in order to enhance the acquisition of their science process skills.
2. Seminars and workshops should be organised for biology teachers on how to adopt and use project-based learning in the teaching and learning process of biology.

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