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RELATIVE EFFECTIVENESS OF PRACTICAL AND PROJECT-BASED LEARNING ON STUDENTS' SCIENCE PROCESS SKILL ACQUISITION IN BIOLOGY IN AGUATA EDUCATION ZONE

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ABSTRACT

The study explored the relative effectiveness of practical and project-based learning on students' science process skill acquisition in Biology in Aguata Education zone of Anambra State. Three purposes of study, two research questions and two hypotheses guided the study and relevant literature were also reviewed. The study adopted a quasi-experimental design with a population of 1098 and sample of 105 (57 males and 48 females) of SS 2 Biology students. The sample was obtained using multi-stage sampling procedure. Science Process Skill Acquisition Test was used as instrument for data collection. The instruments were subjected to face and content validation. SPSAT reliability of 0.94 was established using Kudder Richardson 20. Mean and Standard Deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The study revealed that students in the practical based learning group have higher science process skill acquisition score than those in project-based learning group. However, there was no significant differences in students' science process skill acquisition of observing, inferring, classifying, communicating, measuring, and predicting. The study also observed that female students have higher science process skill acquisition than their male counterpart in the use of practical based learning while male students' science process skill acquisition is better than their female counterpart in the use of project-based learning. From the findings it was concluded that practical based learning boosts science-process skills acquisition in Biology. From the conclusions, implication was that stake holders should advocate for universal, equitable and varied instructional strategies. Teacher's adoption of a blended approach that leverage strengths of both methods was recommended.

Keywords: Science Process skill acquisition, Biology, Practical and Project-based learning.

Introduction

Biology as a science subject in the secondary level of education is essential and forms a vital part of the science curriculum as it supplies students with a thorough comprehension and understanding of the living component of life. According to Alane and Scottfield (2022) it is the study of all living organisms which comprises of plants, animals and micro-organisms present, scarce and in extinction. Biology is a vital subject to study as it provides insight into the various ways in which living and non-living things interact with one another and function in the ecosystem.

Despite having just two main branches (Zoology and Botany), Biology encompasses a wide range of subjects that are divided into numerous sub-fields and specialties. Biology being a diverse field

is frequently studied in cooperation with other academic disciplines including engineering, mathematics, and social sciences.

Even though, Biology is no longer regarded as a compulsory subject in Nigerian senior secondary schools, however non-science students still show a great deal of interest in the subject (Matazu and Isma'il, 2024). Based on the aforementioned, it is essential that Biology students should have a solid understanding of the subject in order to acquire the science process skills that learning Biology encompasses.

Science Process Skills (SPS) are defined as wide ranging conveyable abilities, relevant to many science disciplines that portrays the behaviour of Scientists which includes Observing, inferring, classifying, communicating, measuring, predicting etc. According to Anjugam and Chellamani (2024), science process skills (SPS) are critical to cultivate in science education because they enable students to think critically and generate findings that can be supported by scientific ideas. Students can build and acquire new knowledge or reinforce existing knowledge by using science process skills.

Science process skills when acquired by students in Biology will help them develop into persons who can grasp and comprehend information, enabling them to apply the knowledge they learn in their external examinations like the West African Examination Council (WAEC) and National Examination Council (NECO) practical exams. In the light of this, the weaknesses stated in the Biology WAEC Chief Examiner's reports of year 2022 and 2023 in line with science process skills (SPS) they lack includes: not including the magnification of the diagrams which shows poor measurement skills, using wooly guidelines in labelling diagrams which shows poor communication skills, making diagrams without the correct specification and labelling the guidelines that were not ruled which shows poor measuring skills, wrong spelling of some technical terms which shows poor communication skills, inability to carry out critical observation on specimens provided before answering questions on them which shows poor observational skills, inability to state the functions performed by each of the labelled parts of the drawing that shows lack of classifying skills amongst others were all practical related.

To this, Zeidan and Jayosi (2015) stated that science process skills serve as a driving force for the growth and development of positive attitudes and values of science in students. They added that science process skills raise interests in students to learn science. For an effective acquisition of science process skills, learning strategies that are activity oriented, problem solving and student centered should be adopted by the teachers in order to arouse the interest of the students to learn and develop science process skills thereafter. Hence, the need to exploit the practical and project-based learning methods that are activity oriented and student centered in the course of teaching, drawing and acquiring knowledge of concepts in Biology to examine its relative effectiveness on students' science process skills acquisition in Biology in secondary schools.

Project-based learning is a teaching strategy that focuses, directs and motivates the students to tackle real world problems on their own with little or no guide in order to achieve their set goals with promotion of collaboration and teamwork among students.

According to Ulya (2022), the project approach is a concentrated, problem-based learning experience that fosters achievement and productive collaboration, where students gain greater significance than the teacher's imparted knowledge with the teacher serving as the motivational force and the students eagerly completing most of the work. This is because it is a part of real life and is completed in its natural environment, the project approach allows work to be completed in a friendly manner.

Outi and Maija (2021) noted that Project methods include elements that encourage collaboration between teachers and students, with the primary goal being for students to recognize and comprehend each step needed to reach a logical conclusion. Project-based learning is notably a promising teaching method in education that has gained momentum and lots of potentials to enhance science process skills and engages students in real-world tasks. On the other hand, practical method of teaching which is seen as a teaching method that gives the students first-hand information of living and non-living organisms and its processes is a must for Biology students and should be embraced as it will increase the students' enthusiasm to develop interest in Biology.

According to Omeodu (2018), practical work increases knowledge acquisition of the learners, develops skills and competencies required to meet scientific and technological demands of the nation, makes scientific phenomena more real and during the practices, social interaction is enhanced. When Biology is taught through practical activities (experimentation), it is expected that the students learn more, retain it longer, seem more satisfied with their practical work, and do better on exams than when other teaching strategies are used.

The best way for most students to enhance their Biology learning and acquisition of science process skills is through hands-on activities. As noted by Hamisu (2017), it helps them to progress within each topic from the handling of actual objects to a stage where pictures or diagrams can be used to represent these objects and finally to a stage where symbols are used that can be manipulated in abstract ways. This allows them to think through the biological ideas that are contained within the various activities they undertake at the same time they are carrying out these activities. Practical method is no doubt a teaching method that engages the students to conduct laboratory experiments, observe and analyze phenomena over the theory aspects learned on a topic or before the topic with the ethics of science inculcated into the students in the process of the practical activity. This practical learning method which can be done in the laboratory, workshop and as a field trip, etc. will nurture, guide and develop the students' interests as they look forward to learn Biology which will in turn enhance the interest of the students. Moreover, the students' science process skills may not only be affected by the teaching methods used in teaching but also may be influenced by students' gender.

Gender is a significant variable in educational research, academics and educators continue to be concerned about it. The difficulties surrounding gender equity have become more nuanced and sophisticated in recent years, making it impossible to completely benefit from education in a setting where stereotypes of gender discrimination are fostered (Muokwe, 2021). Gender bias remains widespread in Nigeria, continuing even in science classrooms. It is concerning that female students still believe that projects and practical work are the domain of men, and this belief has caused them to become disinterested in the task given to them. Therefore, it is important to plan and implement science education activities such that boys and girls have equal opportunity to learn and apply science. Teachers should also give work in groups and not gender based like boys should bring these while girls should bring this, let all be grouped together irrespective of gender so that the females will not feel that difficult work or concepts are done by the males.

It is obvious that students will acquire, develop science process skills in Biology lessons if given the opportunity, time and gender unbiased to do practical and project activities on their own. Hence the need for the study, relative effectiveness of practical and project-based learning on students' science process skills acquisition in Biology in Aguata Education Zone.

Statement of the Problem

The West African Examination Council (WAEC) assess students' level of acquired science process skills through the use of practical examinations in Biology and other related science subjects. Where the students are required to carry out certain Biology practicals on some selected contents under strict instructions. Yet the reports from WAEC Chief Examiner (2023) keep revealing numerous candidates' weaknesses which depicts lack of acquisition of science process skills which may stem from inadequate exposure of learners to practicals, inappropriate teaching strategies, teacher centered learning and the use of conventional ways of teaching Biology in most public secondary schools. These strategies did not help students learn in detail the process of analyzing, inferring, predicting and arriving at a conclusion. In addition, these strategies may not allow the students develop their science process skills and show of great interest in the subject hence, the low enrolment of Biology students in the external examinations every year. To this end, the researcher seeks to find the relative effectiveness of practical and project-based learning on students' science process skill acquisition and interest in Biology in Aguata Education Zone.

Purpose of the Study

The main purpose of the study is to examine the relative effectiveness of practical and project-based learning approaches on students' science process skills acquisition in Biology in Aguata Education Zone. Specifically, the study sought to determine the:

1. Science process skills acquisition mean scores of students exposed to practical and project-based learning in Biology in Aguata Education Zone.
2. Science process skill acquisition mean scores of male and female students when taught Biology using practical and project-based learning approach in Aguata Education Zone
3. Interaction effect of gender and instructional strategies on the science process skill acquisition mean scores of students in Biology

Research Questions

The study seeks to find answers to the following research questions:

1. What are the science process skill acquisition mean scores of students exposed to practical and project-based learning in Biology Aguata Education Zone?
2. What are the science process skill acquisition mean scores of male and female students when taught Biology using practical and project-based learning approach in Aguata Education Zone?

Hypothesis

The following hypotheses were formulated for the study and they were tested at 0.05 level of significance.

1. There is no significant difference in the science process skills acquisition mean scores of students exposed to practical and project-based learning in Biology.
2. There is no significant difference in the mean scores of male and female students in science process skill acquisition when taught Biology using practical and project-based learning approach.

Method

The study adopted a quasi-experimental research design of pre-test and post-test. The study was carried out in Aguata Education Zone of Anambra State. The population of this study comprised of all the 1098 (senior secondary year two Biology students (546 males and 552 females) that are offering Biology in Aguata Education Zone of Anambra State. The sample for the study was one hundred and five (105) Biology students (57 males and 48 females). The sample of the study was obtained using multi-stage sampling procedure in five stages. The instruments that were used for data collection for this study was Science Process Skills Acquisition Test (SPSAT). The instruments were validated by three experts. The reliability coefficient of the SPSAT was established using Kuder Richardson Formula 20 and internal consistency of 0.94 was obtained. Mean and Standard Deviation were used to answer the research questions. Analysis of Covariance (ANCOVA) was used to test the hypothesis at 0.05 level of significance ($p<0.05$). It was used in order to eliminate the error of non-equivalence.

Results

Research Question 1: What are the science process skill acquisition mean scores of students exposed to practical and project-based learning in Biology Aguata Education Zone?

Table 1: Mean and Standard Deviation of Science Process Skill Acquisition Scores of Students Exposed to Practical and Project-based Learning in Biology

		Pretest		Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
Practical	48	40.08	13.25	77.60	5.52	37.52
Project	57	32.47	12.64	70.30	9.66	37.83.

The result presented in Table 1 reveals the pretest and post-test science process skill acquisition scores of students taught Biology using practical and project-based learning approaches. The

pretest mean science process skill acquisition scores for the groups in the practical and project-based learning are 40.08 and 32.47 with standard deviation scores of 13.25 and 12.64 respectively. The post-test mean science process skill acquisition scores are 77.60 and 70.30 with standard deviation scores of 5.52 and 9.66. The standard deviation scores for the pretest for both groups were higher than the standard deviations for the posttest. This suggests more variability in the pretest mean science process skill acquisition scores of the students than the posttest mean science process skill acquisition scores. More of the scores near the mean in the pretest than in the post test. Since the pretest mean science process skill acquisition score is smaller than the posttest mean science process skill acquisition score in both groups, the practical based learning improves students' science process skill acquisition in Biology than project-based learning.

More so, the mean gain science process skill acquisition scores of students taught Biology using Practical and those taught using project-based learning are 37.52 and 37.83 which depicts that the students in the practical based learning taught Biology have higher science process skill acquisition score than those taught the same Biology concept using project-based learning.

Research Question 2: What are the science process skill acquisition mean scores of male and female students when taught Biology using practical and project-based learning approach in Aguata Education Zone?

Table 2: Mean and Standard Deviation of Science Process Skill Acquisition Scores of Male and Female Students Exposed to Practical and Project-based Learning in Biology

		Pretest		Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
Practical	48					
Male	26	37.92	13.89	77.46	6.75	39.54
Female	22	42.64	12.27	77.77	3.74	35.13
Project	57					
Male	31	33.77	12.95	71.58	9.48	37.81
Female	26	29.09	9.82	69.81	11.17	40.72

Table 2 shows mean and standard deviation science process skill acquisition scores of male and female students taught Biology using practical and project-based learning. From the result the pretest and posttest mean science process skill acquisition score of male students taught Biology using practical based learning were 37.92 and 77.46 while the standard deviations were 13. 89 and 6.75 with mean gain scores of 39.54. Also, the pretest and posttest mean of science process skill acquisition score of female students taught Biology using practical based learning were 42.64 and 77.77 while the standard deviations were 12.27 and 3.74 with mean gain scores of 35.13. The standard deviation scores in pretest for the male and female students were higher than the standard deviations in posttest. This suggests more variability in pretest scores than the posttest scores in both male and female students taught Biology using practical based learning. Since posttest mean score for female is higher than the posttest mean score of the male, the female students' science process skill acquisition is higher than their male counterpart in use of practical based learning.

More so, the result from table 2 also reveals that the pretest and posttest mean science process skill acquisition score of male students taught Biology using project-based learning were 33.77 and 71.58 while the standard deviations were 12.95 and 9.48 with mean gain scores of 37.81. Also, the pretest and posttest were 29.09 and 69.81 while the standard deviations were 9.82 and 11.17 with mean gain scores of 40.72. The standard deviation scores for the pretest for male students is higher than the standard deviations for posttest. This suggests more variability in pretest scores of male students than their posttest scores. While the standard deviation scores for the pretest for female students is lower than the standard deviations for posttest. This suggests more variability in posttest scores of female students than their pretest scores. This implies that male students' science process skill acquisition is better than their female counterpart in the use of project-based learning in the Biology concepts taught.

Hypothesis 1: There is no significant difference in the science process skills acquisition mean scores of students exposed to practical and project-based learning in Biology.

Table 3: Analysis of Covariance (ANCOVA) of Students' Mean Science Process Skills Acquisition Scores between Practical and Project-based Learning in Biology.

Source	Type III Sum of Squares	df	Mean Square	F	Sig	Decision
Corrected Mode	l1571.035[a]	2	785.517	4.679	.011	
Intercept	1022.432	1	1022.432	6.090	.015	
Posttest Practical And Project SPSAT Learning Strategies	62.150	1	62.150	.370	.544	.004
Practical And Project	1027.562	1	1027.562	6.120	.015	S
Error	17125.727	102	167.899			
Total	154417.000	105				
Corrected Total	18696.762	104				

a. R Squared = .084 (Adjusted R Squared = .066)
b. Computed using alpha = .05

The results in Table 5 reveals that there is significant difference in the science process skills acquisition mean scores of students exposed to practical and project-based learning in Biology, F(1,1027.562) = 6.120, p = 0.015. Since the obtained p-value is less than the stipulated 0.05 level of significance, the null hypothesis which stated that there is no significant difference in the science process skills acquisition mean scores of students exposed to practical and project-based learning in Biology is thereby rejected. This implies that the mean science process skills acquisition score of students taught Biology concept using practical and project-based learning has a significant difference in mean science process skills acquisition scores in respect to this study. This implies that there is a significant difference in the science process skills acquisition mean scores of students

exposed to practical and project-based learning in Biology in favour of those taught with practical based learning.

Hypothesis 2: There is no significant difference in the mean scores of male and female students in science process skill acquisition when taught Biology using practical and project-based learning.

Table 4: Analysis of Covariance (ANCOVA) of Male and Female Students' Mean Science Process Skills Acquisition Scores between Practical and Project-based Learning in Biology.

Source	Type III Sum of Squares	df	Mean Square	F	Sig	Decision
Corrected Mode	l756.838[a]	2	378.419	2.152	.122	
Intercept	448.667	1	448.667	2.551	.113	
Posttest Practical And Project SPSAT	509.467	1	509.467	2.897	.092	
Gender Practical And Project	213.366	1	213.366	1.213	.273	NS
Error	17939.924	102	175.882			
Total	154417.000	105				
Corrected Total	18696.762	104				

a. R Squared = .040 (Adjusted R Squared = .022)
b. Computed using alpha = .05

The results in Table 6 reveals that there is no significant difference in the mean scores of male and female students in science process skill acquisition when taught Biology using practical and project-based learning, F (1,213.366) =1.213, p = 0 .273. Since the obtained p-value greater than the stipulated 0.05 level of significance, the null hypothesis which stated that there is no significant difference in the mean scores of male and female students in science process skill acquisition when taught Biology using practical and project-based learning is uphold. This implies that there is no significant difference in the mean scores of male and female students in science process skill acquisition when taught Biology using practical and project-based learning.

Discussion of Findings

The findings of the study reveals that students in the practical based learning group taught Biology have higher science process skill acquisition score than those taught the same Biology concept using project-based learning in Table 1. The reason could be practical-based learning enables direct hands-on exploration, immediate feedback, and concrete variable manipulation. The finding is also in line with (Anaekwe and Nnaka, 2020) who indicated in their different findings that practical based learning improves students' science process acquisition more than traditional learning process. The study also shows that female students slightly have higher science process skill acquisition than their male counterpart in the use of practical based learning in the Biology concepts taught while male students' science process skill acquisition is better than their female counterpart in the use of project-based learning in the Biology concepts taught. The findings of the study also show there is no significant interaction effect of gender and instructional strategies on

the science process skill acquisition mean scores of students in Biology. This implies that the instructional strategies (practical and project-based) have equal effect on male and female students' science process skill acquisition in Biology concepts taught. The finding is in accordance with Abidoye (2017) who revealed the effectiveness of Biology teachers in science process skill of observing, inferring, classifying, communicating, measuring and predicting, interaction was not significantly influenced by gender and years of teaching experience.

Conclusion

Based on the investigation into relative effectiveness of practical and project-based learning on students' science process acquisition in Biology in Aguata Education Zone it can be concluded among others that students in the practical based learning taught Biology have higher science process skill acquisition score than those taught the same Biology concept using project-based learning. Furthermore, female students slightly have higher science process skill acquisition than their male counterpart in the use of practical based learning in the Biology concepts taught while male students' science process skill acquisition is better than their female counterpart in the use of project-based learning in the Biology concepts taught.

Recommendations

Based on the findings of the study, and the conclusion drawn, the following recommendations are made:

1. All stake holders should prioritize practical-based learning (PBL) for Biology instruction and other science instructions in science subjects.
2. Teachers should always give assessment that align with science process skill acquisitions and interest dimensions in Biology concepts so that the students will be acquainted with it.

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