



## Effects of Ethno-Science-Based and Laboratory Instructional Approaches on Students' Attitude and Academic Achievement in Biology in Onitsha Education Zone of Anambra State, Nigeria

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### Abstract

This study investigated the effects of ethno-science based and laboratory instructional approach on students' attitude and academic achievement of Biology students. A research question answered using mean and standard deviation and a correspondent null hypothesis tested at 0.05 level of significance using ANCOVA, guided the study. The study adopted quasi-experimental research design of the pretest posttest non-equivalent treatment group. A sample size of 123 (52 males and 71 females) drawn through multistage sampling procedure was used. Biology Achievement Test (BAT) and Biology Attitude Scale (BAS) were the two instruments used for data collection. BAT and BAS were validated by three experts. The internal consistency reliability indices for the instruments were determined to be 0.88 and 0.79 respectively using Kuder Richardson Formula 20 (K-R 20) and Cronbach alpha method. The students were assigned into two experimental groups of ethno-science and laboratory instructional approaches and the experimental procedures lasted for six weeks. The results of the study revealed that the instructional approaches improved Biology students' attitude and academic achievement but ethno-science based approach better significantly enhanced the students' attitude and academic achievement. The findings further showed that gender significantly influenced the attitude and academic achievement of students in Biology in favour of female students. The study concludes thus, that instructional approaches are potent in improving students' attitude as well as academic achievement of students in Biology. Therefore, it was recommended among others that Biology teachers and instructors should adopt instructional approaches such as ethno-science and laboratory instructional approaches in order to improve students' attitude and academic achievement in Biology.

**Keywords:** Academic Achievement, Attitude, Biology, Ethno-science, Laboratory Instructional Approach, Science

### Introduction

Science is an indispensable tool for sustainable national and human development. It is the body of knowledge accumulated through the discoveries about all the things in the universe. Science can also be seen as a systematic and logical approach to discovering how things in the universe work (Alina & Ashley, 2017). Science, according to Bhattacharjee (2023) is classified into different categories; social science, natural science, physical science, and applied science. Biology is classified under natural science.

Biology is the study of life. It is simply considered as the study of living things. It is a natural science concerned with the study of life and living organisms (Nwuba & Osuafor, 2021). Hence, it is a branch of science that studies living things and their interactions with each other and their environment. Despite the importance of Biology, there has been

inconsistency in students' academic achievement in the subject over the years (WAEC chief examiner's reports; 2016-2019; 2021). Evidence abounds that students' academic achievement in Biology has been inconsistent. Some of reviewed Onitsha Education Zone domicile West African Examination Council (WAEC) (2016-2019) results showed that the inconsistency in students' Biology reflected in those years. The WAEC chief examiners' report (2016-2019; 2021) revealed that although there was an improved/better academic achievement in the year 2017 with a raw mean score of 31 and standard deviation of 11.92 when compared with the previous year 2016 which had a raw mean score of 31 and standard deviation of 10.91, there was a decline in students academic achievement the following year (2018) with a raw mean score of 30 and standard deviation of 9.00. The above studies have shown that

there is inconsistency in academic achievement of Biology.

Studies attributed the inconsistency in academic achievement of students in Biology to many factors. The works of Uzoma and Okoli (2019), Ufommadu and Okoli, (2019), Nwuba and Osuafor (2021) have attributed this unsatisfactory achievements to many factors to include lack of adequate laboratory facilities and instructional aides, un- conducive learning environment, wide content of secondary school Biology curriculum, and most importantly, the predominant use of conventional method of teaching (lecture method) in the classroom. This has led to the inability of students to grasp the full contents of Biology which invariably lead to students' inconsistency in academic achievement of Biology. This created a concern for the researcher to investigate if students' understanding of Biology concepts as well as academic achievement in Biology can be improved using an innovative teaching approach like ethno-science based instructional approach.

Ethno-science based instructional approach is one of such identified approaches that are culturally-relevant to the teaching and learning of Biology. Ethno-science otherwise referred to as indigenous knowledge or culturally relevant science is a vital innovative approach in the teaching and learning process. Ethno-science enables students to understand and master concepts in Biology by attributing them to their day-to-day experiences. According to Fasasi (2017), ethno-science is the instructional approach that systematically assesses the prior cultural beliefs, as well as an environmental experience and ideas of learners that are related to the science concept being taught to ensure a more profound understanding of the concept. The benefit of the instructional approach is such that the gap in knowledge of the students and their culture and the new field of knowledge is bridged (Ayua, Tofi, Ohadiugha & Daniel. 2023). Ethno-science translates the knowledge of a community's native perceptions, knowledge gained from experience and beliefs that have scientific facts. According to Okwara and Upu (2017), Ethno-science refers to the materials, ideas, beliefs and technology in a given society or environment, that derive from the past and present cultural practices and traditions. Ethno-science represents indigenous technical knowledge, traditional environment knowledge, and rural knowledge, among others. Such knowledge is creative, experimental, and innovative to the needs of changing conditions.

In the Ethno-science classroom, the teacher introduces the lesson by presenting students with

cultural practices and knowledge related to the concept. The teacher gives a brief explanation of the concept and calls on the students to present other cultural knowledge related to the concept as the instruction proceeds step by step.

The works of Ephraim and Gurudas (2019) on the effect of ethno-physics-based instruction on students' academic performance and attitude towards density, forces and heat transfer in college physics in Mufulira College of Education indicated that ethno-physics instructional approach is a viable innovation for the enhancement of students' academic performance and attitude towards physics.

Although the reviewed study is related to the present study as both looked into students' attitude in ethno-science instruction, the present study differs from the reviewed work in terms of subject used (Biology and Physics, respectively) and also, the reviewed study used traditional teaching method (lecture method) to control ethno-science while the present work worked with two innovative instructional approaches (ethno-science and laboratory) as non-equivalent control groups. This necessitated the present work. While ethno-science based instructional approach represents the relation of biological concepts with students' belief for better understanding, another approach that could improve students' understanding and mastery of biological concepts through experiment is the Laboratory instructional approach (Tersoo, 2018).

Laboratory instructional approach is simply the practical application of the knowledge of a subject during teaching and learning. Omiko (2015) defined laboratory approaches as the use of experiments to demonstrate practically some principles taught in theory, test the validity of certain facts and illustrate properties of substances taught theoretically in the classroom. The laboratory approach provides opportunities for students to actually experiment instead of only learning about the subject (Babafemi, 2016). The use of a laboratory instructional approach provides a sense of practice and hands-on-minds-on activity during the teaching and learning process, which can stir up students' attitude towards the understanding of Biology concepts. The work of Adesoji (2018) revealed that at least, eighty percent (80%) of scientific information or principles are passed on to students through the laboratory instructional approach. The author further pointed out that our educational system puts much premium on external examination and the laboratory instructional approach helps biology teachers in driving home instructions through practical. Thus, the laboratory instructional approach places authority on the subject by making learners in a biology classroom to be part

of the learning process to meet with the syllabus for external examinations. Several researches have been conducted to assess the effectiveness of laboratory instructional approach in Biology. However, results of such studies have not been in agreement. Achimugu (2018) reported that laboratory instructional approach enhanced better academic achievement of student's achievement. On the contrary, Babafemi (2016) reported that successive efforts to improve teaching and learning, like the use of laboratory method, have not yielded any improvement in students' performance. Therefore, due to the contradictory reports above and considering the benefits of the laboratory instructional approach as stated by various studies, the researcher intends to investigate the effects of ethno-science-based and laboratory instructional approach on students' academic achievement and attitude.

Attitude can be simply defined as any concept that specifies an individuals' feeling, action, or thinking towards a certain perspective or thing. Attitude, according to Abum, Antonio, Alipio & Reginald (2023) is an individual's disposition to react to a certain object, behavior, person, institution, event or another discriminable aspect of the individual's world. Attitude could be positive, negative or neutral depending on the experience (Iliyasu, 2015). When students develop a positive attitude towards biological concepts, it could improve their academic achievement in Biology. Therefore, students' attitude is one of the factors that may play a role in the future academic achievement of Biology students (Adesoji, 2018).

Academic achievement is a description of students' educational activities which measures their level of subject knowledge. It refers to an outcome of formal education which plays an important role in students' lives (Kell, Lubinski & Benbow, 2013). Academic achievement relates to students' ability to recall and convey the knowledge or skill they have learned or studied orally or in writing in an examination (Verešová & Maláa, 2016). Students' academic achievement is evidential in the students' scores gotten at the end of every teaching and learning process, whether in short or long term basis. These scores which are categorized in grades tend to help in determining the students' placement in future academic pursuits. Sallau, Abubakar and Yau, (2018) affirms that any nation that is highly ambitious to be scientifically and technologically advanced must have a suitable level of knowledge in Biology.

The inconsistency in academic achievement of students in Biology has been of great concern to preceding researchers. Anaduaka and Okafor, (2013)

recorded that some efforts by the government of Nigeria and researchers have been made to improve students' achievement in Biology. The researchers reported that several conferences, workshops, seminars and in-service training were organized by the Ministries of Education and Government agencies like Post Primary School Service Commission (PPSSC) with a view to tackling or redressing the problem of academic achievement of students in Biology and helping Biology teachers with useful knowledge in teaching the subject. In line with this, this study intended to determine how the use of ethno-science and laboratory instructional approaches could enhance students' attitude towards Biology and academic achievement in Biology, irrespective of the students' gender.

### Research Question

Two research questions guided the study:

1. What is the mean attitude scores of students taught Biology with ethno-science-based instructional approach and those taught with laboratory instructional approach?
2. What is the mean achievement scores of students taught Biology with ethno-science-based instructional approach and those taught with laboratory instructional approach?

### Hypothesis

Two null hypotheses which were tested at 0.05 levels of significance guided the study:

**Ho<sub>1</sub>:** There is no significant difference between the mean attitude scores of students taught Biology with ethno-science-based instructional approach and those taught with the laboratory instructional approach.

**Ho<sub>2</sub>:** There is no significant difference between the mean achievement scores of students taught Biology with ethno-science-based instructional approach and those taught with the laboratory instructional approach.

### Materials and Methods

#### Design for the study

The study employed quasi-experimental design, specifically pre-test post-test non-equivalent treatment group design. According to Nworgu (2015) quasi-experimental design is an experiment where complete randomization of subjects to experimental and control groups is not possible. The design was considered appropriate for this study because there was no randomization of the subjects. Intact classes were used in the study in order not to disrupt the normal classroom arrangement.

### Area of the Study

The study was conducted in Onitsha Education Zone of Anambra State. Onitsha education zone comprises 3 Local Government Areas (LGA) namely: Onitsha North, Onitsha South, and Ogbaru Local Government. This study used Onitsha Education Zone as its area of study because the education zone is predominantly occupied by farmers and businessmen/women who may not have ample time to support positively towards enhancing desired students' academic achievement.

### Population of the Study

The population of this study comprised 6,770 senior secondary one (SS1) students in all the secondary schools in Onitsha Education zone (Planning, Research, and Statistics Unit, Post Primary School Service Commission (PPSSC) Onitsha, Anambra state as at 2021/2022 session.

### Instrument for Data Collection and Study Procedure

Two instruments were used in collecting data for the study; Biology Achievement Test (BAT) and Biology Attitude Scale (BAS).

The BAT was based on SSI Biology curriculum content taught to both experimental groups which was developed by the researcher and was used to determine students' achievement in Biology. Twenty-five (25) questions for BAT were formulated from the topic used in this research work which is "Cell and its environment"; (diffusion, osmosis, hemolysis/crenation and plasmolysis/turgidity) as contained in Biology scheme of work for SS1 and the 25 test items survived validation with some modifications. The test items were constructed based on the Biology topic drawn from S.S 1 Biology syllabus used for the study, which is "Cell and its environment"; using Bloom's Taxonomy table of specification. Each question correctly answered was awarded four (4) marks, making it a total of 100 marks in all. Marking guides for BAT was used for scoring. It measured the contents taught in the present work and suits the study.

The second research instrument was the BAS, which was based on the 4-point Likert scale. The BAS also contained twenty-five (25) items which were developed by the researcher. The BAS consisted of both positive and negative Biology attitude item statements. Responses of the scale were rated on a 4-point scale ranging from 1-4 where: 4 = Strongly Agreed, 3 = Agreed, 2 = Disagreed, and 1 = Strongly Disagreed for positively worded items. On the other hand, negatively worded items were scored in the

order of: Strongly Agreed = 1 point, agreed = 2 points, disagreed = 3 points and Strongly Disagreed = 4 points. The BAS was used for both pre and post tests.

The instruments; BAT and BAS, were attached together with lesson plans prepared for the two instructional approaches and were validated by three specialists; one from the Biology Education, one from the Research, Measurement, and Evaluation and one from Psychology unit, to ensure they measure what they intended to measure. The final version of the Biology Attitude Scale (BAS) contained the initial 25 items with some modifications, which were re-numbered serially.

The researcher was able to confirm the reliability of the instruments by trial-testing them on twenty-five (25) SS1 Biology students in Awka Education Zone, which shares a similar characteristic as that of the students in Onitsha Education Zone, but is not part of the study area. The reliability coefficient of the BAT was determined using Kuder Richardson Formula 20 (K-R 20) and the reliability value of 0.88 was obtained. Kuder Richardson Formula 20 (K-R 20) was used because the items are dichotomously scored.

The reliability of Biology Attitude Scale (BAS) was obtained using Cronbach-Alpha reliability estimate and the reliability value of 0.79 was obtained. This is because the procedure applies to the instruments or items that are non-dichotomously scored, or the items are polychotomously scored (i.e., instruments with more than two (2) responses in which none is correct or incorrect).

### Sample and Sampling Technique

Multistage sampling procedure was used to draw 123 senior secondary one (SS1) Biology students from the population of the study.

In the first stage, the researcher used the simple random sampling technique to draw one local government area out of the three local government areas in Onitsha Education Zone. In the second stage, the researcher purposively drew all the co-educational schools within the sampled local government area. In this, seven (7) co-educational schools emerged.

In the third stage, the researcher used simple random sampling technique by balloting (with replacement) to draw two (2) co-educational schools from the seven (7) co-educational schools that emerged from the local government area. This technique was used to give each of the school equal opportunity to be selected.

In the fourth stage, for each of the schools sampled, a class was drawn using simple random sampling technique in case of multiple streams of SS1 classes,



thereby making a total of two (2) intact classes. This technique was used to give each of the class equal opportunity to be selected. The two schools were grouped into A and B respectively where group A school was assigned to be taught Biology using ethno-science based instructional approach and group B school was assigned to be taught Biology using laboratory instructional approach. In group A school, seventy-five (75) S.S. 1 students emerged. In group B, forty-eight (48) S.S. 1 students emerged (18 males and 30 females) making it a total sample of 123 S.S. 1 students for the study.

### Method of Data Analysis

The data collected from the administration of tests were analyzed using mean and standard deviation to answer the research questions while the null hypotheses were tested using analysis of covariance (ANCOVA) at 0.05 level of significance. ANCOVA was used to partial out the initial difference between the two different treatment groups. The Statistical tool that was used to run the analysis is the Statistical Package for Social Science, (SPSS) version 23.0.

### Results

The results of this study were presented in the tables according to the research questions and the corresponding hypotheses.

**Table 1: Mean and standard deviation on the mean attitude scores of students taught Biology using ethno-science based instructional approach and those taught with laboratory instructional approach**

Instructional Approaches	N	Pre-Test		Post-Test		Mean Gain
		$\bar{X}$	SD	$\bar{X}$	SD	
Ethno-Science	60	38.17	10.28	64.48	6.65	26.31
Laboratory	63	31.00	8.32	46.16	6.79	15.16

Table 1 indicates the mean attitude scores of students taught Biology using ethno-science -based and laboratory approaches. From the results, students taught Biology using ethno-science instructional approach had a mean attitude score of ( $\bar{X}$ = 38.17, SD=10.28) for pre-test and ( $\bar{X}$ = 64.48, SD=6.65) for post-test with a mean gain of 26.31. More so, Table 1 shows that students` exposed to laboratory approach had a mean attitude score of ( $\bar{X}$ = 31.00, SD=8.32) for pre-test and ( $\bar{X}$ = 46.16, SD=6.79) for post-test with a

mean gain of 15.16. This is an indication that ethno-science based and laboratory approaches are potent in improving the attitude scores of students in Biology. Nevertheless, ethno-science based proved to be more potent in increasing the attitude scores of Biology students` more than laboratory approach. The standard deviation of 10.28 and 8.32 for pre-test, 6.65 and 6.79 for post-test of ethno-science and laboratory instructional approaches respectively, show that both groups are homogenous groups effective in improving students` attitude scores.

**Table 2: ANCOVA result on the significant difference in the mean attitude scores of students taught Biology using ethno-science based and laboratory instructional approaches**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Squared	Eta
Corrected Model	10154.064 <sup>a</sup>	4	2538.516	65.991	.000	.691	
Intercept	11304.459	1	11304.459	293.868	.000	.714	
Pre Attitude	685.075	1	685.075	17.809	.000	.131	
Approach	4698.191	1	4698.191	122.133	.000	.509	
Error	4539.204	118	38.468				
Total	381507.000	123					
Corrected Total	14693.268	122					

a. R Squared = .691 (Adjusted R Squared = .681)

The analysis of the result presented in Table 2 reveals the ANCOVA result on the significant difference in the mean attitude scores of students

taught Biology using ethno-science-based and laboratory instructional approaches. From the result, the F-value of 112.13 obtained has an associated

exact probability value of 0.000. Since the associated p-value of 0.000 is less than 0.05 level of significance, the null hypothesis is rejected. Based on this, it can be concluded that there is a significant difference in the mean attitude score of students when taught ethno-

science-based and laboratory instructional approaches. Furthermore, the partial eta-squared ( $\eta^2_p$ ) of 0.509 is an indication that 50.9% of the increase in the mean attitude score of students in Biology is as a result of the treatment effect.

**Table 3: Mean and standard deviation on achievement scores of students taught Biology with ethno-science based instructional approach and those taught with laboratory instructional approach**

Instructional Approaches	N	Pre-Test		Post-Test		Mean Gain
		$\bar{X}$	SD	$\bar{X}$	SD	
Ethno-Science	60	34.73	6.24	60.23	6.65	25.50
Laboratory	63	27.16	4.69	43.57	5.14	16.41

The result in Table 3 shows the mean achievement scores of students taught Biology with ethno-science based instructional approach and those taught with laboratory instructional approach. The result shows that students exposed to ethno-science had a mean achievement score for pre-test ( $\bar{X}= 34.73$ ,  $SD=6.24$ ) and post-test score ( $\bar{X}= 60.23$ ,  $SD=6.65$ ) with a mean gain of 25.50. The result also showed that students` laboratory approach had a mean achievement score of ( $\bar{X}= 27.16$ ,  $SD=4.69$ ) for pre-test and ( $\bar{X}= 43.57$ ,  $SD=5.14$ ) for post-test with a

mean gain of 16.41. This result implies that ethno-science and laboratory approaches are potent in improving academic achievement scores of students in Biology. However, ethno-science proved to be more effective. The standard deviation of 6.24 and 4.69 for pre-test 6.65 and 5.14 for posttest of ethno-science and Laboratory instructional approaches respectively show that both groups are homogeneous groups effective in improving students` achievement more than laboratory instructional approach.

**Table 4: ANCOVA result on the significant difference between the mean achievement scores of students taught biology with ethno-science based instructional approach and those taught with laboratory instructional approach**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9898.410 <sup>a</sup>	4	2474.603	101.487	.000	.775
Intercept	4222.066	1	4222.066	173.153	.000	.595
Pretest	1179.667	1	1179.667	48.380	.000	.291
Approach	2910.063	1	2910.063	119.346	.000	.503
Error	2877.250	118	24.383			
Total	341495.636	123				
Corrected Total	12775.660	122				

a. R Squared = .775 (Adjusted R Squared = .767)

Table 4 shows the ANCOVA result for the significant difference in the mean achievement scores of students taught biology with ethno-science based instructional approach and those taught with laboratory instructional approach. The result shows that an F-ratio (119.35) obtained, has an associated exact probability value of 0.000. The associated exact probability value of 0.000 obtained is less than 0.05 level of significance set for decision making. Hence, the null hypothesis was rejected. Inference drawn is that, there is a significant difference in the achievement scores of students taught biology with ethno-science based instructional approach and those

taught with laboratory instructional approach. More so, Table 4 shows a partial eta square ( $\eta^2_p$ ) of 0.503. This means that 50% of the increase in the mean achievement scores of students taught Biology was due to the effect of instructional approaches.

### Discussion

The findings of the study showed that ethno-science based instructional approach and laboratory instructional approach improved students` mean attitude score in Biology. However, ethno-science based instructional approach was more effective in improving students` mean attitude than laboratory

instructional approach. However, the analysis of no significant difference showed that there is a significant difference. Hence, the null hypothesis of no significant difference was rejected. The reason for this result could be as a result of students' interaction with their fellow students. Students gain mastery of the subject and attitudinal change towards the subject. During this interaction, there is a tendency that students' misconceptions, fear, doubts and feeling about the subject matter changes especially where there is effective teaching and learning taking place, and students' attitudes tend to change from negative to positive. Ethno-science based instruction incorporates students' cultural backgrounds and experiences into the learning process. This can make Biology more related and relevant to students' lives, fostering a positive attitude towards the subject. By connecting Biology concepts to students' cultural contexts, ethno-science based instruction may enhance students' engagement and attitude towards the subject. This engagement can contribute to a more positive attitude towards Biology.

The finding of this study is in agreement with that of Fasasi (2017) who revealed that there was a significant mean effect of ethno-science instruction on students' attitude in science. On the contrary, Ivowi (2014) reported that teaching approaches like ethno-science-based approaches adopted by the teacher did not improve students' attitude. In the same vein, Alake (2015) findings showed that students exposed to laboratory instructional strategy achieved, retained the learnt concept and developed more positive attitude to geometry than their counterparts.

The findings of the study showed that ethno-science based instructional approach and laboratory instructional approach improved students' academic achievement. However, ethno-science based instructional approach was more effective in improving students' academic achievement than laboratory instructional approach. However, the analysis of no significant difference showed that there is a significant difference in the two instructional approaches. Hence, the null hypothesis of no significant difference was rejected. The reason for this result could be due to the fact that students enjoy learning when exposed to teaching using instructional approaches that are culturally-related because individuals tend to value culture and religious and could easily learn from them. Also, cultural activities of each child as experienced from his cultural environment guide or influence his or her future observations, and also determine what is learned. This approach has the potential to create a more inclusive learning environment, acknowledging and respecting diverse perspectives. Students from different cultural

backgrounds may feel a stronger sense of belonging in the biology classroom, hence a better learning outcome.

The finding of this study is in line with Damayanti, Rusilowati and Linuwih (2017), who reported that local culture in the learning process, can improve students' critical thinking skills. The students will learn effectively using the environment or things around them thus, it stimulates the students' curiosity. Also, Babafemi (2016) reported that successive efforts to improve teaching and learning like the use of laboratory method, have not yielded any improvement in students' performance. Also, Eko, Meli and Muhammad (2020) reported that ethno-science based direct instruction learning model influenced the students' critical thinking. However, the finding of this study disagrees with that of Odutuyi (2015) who reported that there was a significant relationship between the use of laboratory learning environment and students' performance in chemistry.

### Conclusion

From the findings and discussions of the study, the following conclusion were made: there is a significant difference in the achievement scores of students taught Biology using ethno-science-based instructional approach and those taught using laboratory instructional approach in favour of ethno-science based instructional approach.

### Recommendation

Based on the finding/implication of the study, the following recommendations were made:

- i. Ethno-Science instructional approach should be adopted by Biology teachers in teaching and learning since it enhanced students' achievement and encouraged positive attitude towards the teaching and learning of Biology.
- ii. Biology teachers and students should be trained on how to effectively use Ethno-Science instructional approach in teaching and learning.
- iii. Seminars, workshops and in-service training should be organized by education stakeholders like the Post Primary Schools Service Commissions (PPSSC), among others, for teachers in other to enable them acquire the necessary skills needed in utilizing Ethno-Science instructional approach in teaching and learning.

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