Effects of Interpretation Construction-Based Instructional Strategy on Students' Achievement in Ecological Concepts in Onitsha Education Zone

Akachukwu, Esther Ebele
Department of Biology,
Nwafor Orizu College of Education,
Nsugbe, Nigeria

Okoli, Josephine Nwanneka
Department of Science Education,
Nnamdi Azikiwe University,
Awka, Nigeria

Abstract
The study investigated the effects of interpretation construction-based instructional strategy on students' achievement in biology in Onitsha Education Zone. Two research questions and three hypotheses guided the study. A quasi-experimental design was used. A sample of 178 senior secondary year two biology students was involved in the study. The instrument for data collection were Achievement Test on Ecological Concepts (ATEC) validated by three lecturers; two from the Department of Science Education, and one from the Department of Educational Foundations (Measurement and Evaluation) in Nnamdi Azikiwe University, Awka. The reliability of ATEC was established using Kudder-Richardson Formula 20 for ATEC which yielded coefficient of internal consistency of 0.93. The data obtained were analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA). The findings showed that the effects of Interpretation Construction-based Instructional Strategy (ICOBIS) on achievement scores in ecological concepts was significant when compared with that of those taught using conventional method using their pretest posttest mean scores. Also, effect of ICOBIS on the achievement scores of male and female students in ecological concepts do not differ significantly using their pretest posttest mean scores. The study concluded that interpretation construction-based instructional strategy enhanced students' achievement significantly for all students irrespective of gender. The study recommended that biology teachers should adopt the use of interpretation construction based instructional strategy in teaching ecological concepts.

Keywords: *Achievement; instruction; ecology; gender; construction-based*

INTRODUCTION

The science of ecology deals with the interrelationships among plants and animals, and their non-living environment. According to Ricklefs (2009), ecology is the study of natural environment particularly the interrelationship between organisms and their surroundings. Ecology provides knowledge and an understanding of the mechanism of changes brought about by the interactions of the living things and the effect of the interaction between the living things and their external environment. Its study gives students an opportunity to understand the most important ecological issues affecting the environment. These include the influence of human activity in altering human ecological relationship that is, creating new habitats or downgrading and destroying old ones, the biological

consequences of pollution, waste disposal, pesticide use and misuse and the medical and behavioural difficulties arising from the stresses of modern day life.

Ecology is studied for two reasons; to gain the intellectual gratification that comes from understanding natural patterns and processes and to apply that understanding to environmental problems that confront mankind. Thus, ecological concepts occupy a central position in biology as well as school curriculum. The Federal Ministry of Education (2009) in the national curriculum on biology for senior secondary schools indicated that great emphasis is placed on ecological concepts. The West African Senior School Certificate Examination syllabuses (2013 -2014) showed that the basic ecological concepts to be studied include: components of an ecosystem, local biotic community in Nigeria, and major biomes of the world. A close analysis of the past senior certificate examination questions revealed that ecology questions have dominated in the past years and students' achievements in the area were very poor (WAEC, 2013). The Chief Examiner's report further revealed the errors students commit in ecological concepts which contributed immensely to the poor achievement of students in senior school certificate biology examination (WAEC, 2013).

Achievement is the extent to which the objectives of learning have been achieved (Machr & Archer, 2007). Thus, the level of achievement by senior secondary school students is determined through evaluation of WAEC or NECO examination results. Available evidence on the level of achievement of students in senior school certificate biology examination is quite disturbing and that is why the Chief Examiners reports (2013) showed that majority of the students have poor grasp of the concepts of the ecology. Based on one of the ecology questions out of five questions asked in WAEC 2013 for instance, the students were asked to state five important uses of water to organism in the rainforest. The Chief Examiner's report showed that, in stating uses of water to rainforest organisms, some candidates wrote on the uses of water to man, example drinking, washing and cooking, rather than maintaining body temperature, essential for plant turgidity, necessary for photosynthesis among others. In 2015, the Chief Examiner's report showed that students can make a diagram of the Nitrogen Cycle in place of Carbon cycle, constructed food chain without showing the direction with arrow heads, and generally showed poor response to questions on ecology.

A number of factors have been found to have contributed to students' poor achievement in biology specifically in ecology in Senior School Certificate Examination (SSCE). Maduabum (2015) pointed out that some of these factors include: teachers' ineffectiveness in terms of content coverage and also teachers and students find it difficult to teach and learn respectively. Waheed and Lucas (2012) found out that ecological topics are complex and difficult to represent as they contain many constituent concepts, however, Taylor (2015) opined that students' attitude to ecological concepts, perception, poor study habits and lack of available resource materials contribute to poor achievement in ecology in biology SSCE. The level of achievement of learning outcome between male and female students may be different, hence the issue of gender in science achievement.

Gender as defined by Adegboye (2008) is socially ascribed attribute which differentiates feminine from masculine. Difference in academic achievement due to gender has caused a lot of concern to educationist. Adegboye had explained that many parents do not want to spend much on educating the female child as that of the male child because of their social or cultural environment. Amadi (2007) observed that male students are more inclined to study sciences than their female counterparts. Since biology plays a vital role in technological progress as well as being one of the basic and core subjects taught in Nigerian secondary schools, both male and female should have the same opportunity to study biology. Although gender may influence students' achievement in biology, type of exposure, method of teaching and many other variables may also relate to achievement level.

Many biology teachers adopt the old method of teaching specifically, the conventional method (Augustinah, 2015). Nworgu (2006) explained that this method is only concerned with verbal presentation of concepts and ideas to students. Hence, it does not promote meaningful learning of biological concepts, since students are not actively involved in the learning process. This method is not very good for teaching certain concepts in biology specifically ecological concepts that may require field trips because it only encourages memorization of information without actually promoting meaningful learning. According to Agbai (2015) in many schools in Onitsha Education Zone of Anambra state, the curriculum is held as absolute and teachers adhere to it even when students do not clearly understand important concepts. Studies on how students learn science have revealed some new ideas and innovative instructional approaches that have enhanced students' achievement in school subjects. Examples of such strategies include; the use of analogy, inquiry, cooperative learning, problem solving and interpretation construction. The focus of this study is on interpretation construction.

Interpretation construction-based instructional strategy (ICOBIS) is a set of belief about learning that emphasizes on students' encounter with authentic issues individually; on constructing interpretations by students in groups; searching for information about the problem in groups and facing different interpretation about the problem in groups (Black & McClintock, 2006). Thus, ICOBIS is a group-based teaching and learning approach in which knowledge is constructed by the learners in groups in an attempt to integrate existing knowledge within the new experiences.

In this study, the teacher's use of ICOBIS involved different stages. In the first stage, students were sent out to engage in individual observations. They offer individual interpretation to their observations. The second stage involved interaction with the teachers who noted their misconceptions or previous knowledge. In the third stage, the students were grouped and sent out to engage in group observation. The students gave a group interpretation to the group observation. The students come back again and interacted with the teacher. The teacher then guided the students' learning while engaging them in brief discussions about what they observed. This approach to learning could improve students' achievement.

Researchers (Akin & Karplus, 2016; Cambel 2015, Gergon 2005) demonstrated that interpretation construction strategy has the potential of improving students' learning of science concepts. In view of the revolutionary effects of ICOBIS in other countries other than Nigeria, there is need to test locally its effects on students' understanding of ecological concepts.

PURPOSE OF STUDY

The purpose of the study is to determine the effects of interpretation construction-based instructional strategy on students' achievement in ecological concepts in Onitsha Education Zone. Specifically, the study sought to find out the:

1. Effects of Interpretation Construction-based Instructional Strategy (ICOBIS) on achievement scores of students in ecological concepts when compared with that of those taught using conventional method.
2. Effectiveness of ICOBIS on the achievement scores of male and female students in ecological concepts.
3. Interaction effect of teaching methods and gender on students' achievement in ecological concepts.

RESEARCH QUESTIONS

The following research questions guided the study:

1. What is the mean achievement score of students in ecology taught with Interpretation Construction-based Instructional Strategy (ICOBIS) and those taught with conventional method?
2. What is the mean achievement scores of male and female students in ecology taught with ICOBIS?

HYPOTHESES

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

1. There is no significant difference in the mean achievement scores of students taught ecology with Interpretation Construction-based Instructional Strategy (ICOBIS) and those taught with conventional method.
2. There is no significant difference in between the mean achievement scores of male and female students taught with ICOBIS.
3. There is no significant interaction effect of teaching methods and gender on students' achievement in ecological concepts.

METHOD

The design of this study is quasi-experimental, specifically, a pre-test, post-test, non-randomized control group design involving the use of intact groups. This study was carried out in Onitsha Education Zone of Anambra State. The state has 21 local government areas distributed in three senatorial district. According to the Anambra State Post Primary Schools Services Commission (PPSSC) Onitsha Zone (2016), there are 32 state government owned secondary schools in the zone. The rationale for the choice of the area is based on the fact that Onitsha has sufficient co-educational schools. To ensure that students in both experimental and control groups share a common environment, co-educational schools were used for this study. The population of the study consists of all the 4,824 Senior Secondary school class two (SS2) students consisting of 2,585 males and 2,239 females in the 32 state government owned secondary schools in Onitsha Education Zone of Anambra State. The sample of the study consisted of 178 senior secondary year two (SS2) biology students in Onitsha Education Zone obtained using a multifaceted sampling procedure.

The instruments for data collection were Achievement Test on Ecological Concepts (ATEC). The Achievement Test on Ecological Concepts (ATEC) items covered four (4) units which are; basic ecological concepts, components of ecosystem, local biotic community in Nigeria and major biomes of the world as contained in the senior secondary school biology curriculum. Each question has five answer options A-E. The achievement test time duration was 40 minutes for each student. The content validity of the ATEC was established using the table of specification. The reliability of the instruments was determined using one co-educational secondary school in Ogidi Education Zone of Anambra state. One intact class of 40 SS2 students was used for trial testing. For the Biology Achievement Test on Ecological Concepts (ATEC), the reliability of the instrument was established using Kudder Richardson Formula 20 (KR – 20).This is because the items are dichotomously scored with varied difficulties. The scores from the test were used to obtain a coefficient of internal consistency which was found to be 0.93.

The biology teachers in the selected schools served as research assistants. On the first day of the experiment, the test instruments (ATEC and ISE) were administered as pre-test to all the participants (numbering 178 students) in the sampled schools. After the pretest, the research assistants started the experiment following all the steps involved. The experimental groups were taught using interpretation construction-based instructional strategy. The first step involved the diagnoses of students' prior conceptions or alternative conceptions.

The second step involved exploring the concepts/principles in questions that allow the students to observe the phenomenon using experiments that illustrate the particular concept. The students worked in groups to explore ideas through hands-on activities. Under the guidance of the teacher, they clarified their own understanding of major concepts and skills.

The third step involved the use of a variety of techniques such as explaining or demonstrating phenomena and involved students in purposeful discussion. The fourth step required the students to examine each of their original conceptions in order to find out whether they had really understood ecological concepts. If their beliefs are illogical or intuitive conception, the teacher returned to step 2.

The final step involved assessing students' knowledge, understanding, skills and abilities. This final step also involved students in framing and solving problem, students discuss problems in groups and recorded their plans. Students were given the opportunity to develop on their knowledge by applying the new concepts to real world examples. The research assistants (teachers) asked the students to provide examples of the phenomenon occurring in their own lives and explain the concept in question in the course of exposing the students to Interpretation Construction Based Instructional Strategy (ICOBIS).

The control group was taught by their regular biology teachers at their normal lesson periods using the popular lecture method. The teachers used the lesson plan prepared by the researcher. Immediately after the four weeks treatment period, the ATEC and ISE were again administered to the students as posttest. For the post-test, the items of the instrument had been re-arranged, produced on different colour of paper so as not to make the students test-wise. Students' responses on the pre-test and post-test were graded and their scores were used for data analysis. Only the scores of the students who participated in the pretest and posttest were used for data analysis.

Data relating to the research questions were analyzed using mean, while Analysis of covariance (ANCOVA) was used in testing the null hypotheses at 0.05 alpha level. ANCOVA was used because the research involved the administration of pre-test and post-test before and after the treatment procedure. ANCOVA took care of the initial group differences. The Decision rule was that when the probability value (P-value) is less than 0.05, reject the null hypothesis, otherwise do not reject the null hypothesis.

RESULTS

Research Question 1: What is the mean achievement score of students in ecology taught with Interpretation Construction-based Instructional Strategy (ICOBIS) and those taught with conventional method?

Table 1: Pretest Posttest Mean Achievement Scores of Students taught Ecology using ICOBIS and Conventional Method

Groups	N	Pretest Mean	Posttest Mean	Gain in Mean	Pretest SD	Posttest SD
ICOBIS	90	20.89	42.17	21.28	7.40	8.14
Conventional	88	19.71	34.38	11.67	7.13	6.73

Table 1 shows that the group taught using interpretation construction-based instructional strategy (ICOBIS) had achievement gained mean score of 21.28 and the group taught using conventional method had mean achievement gain score of 11.67. ICOBIS was effective in enhancing the students' achievement. While the use of ICOBIS increased the spread of scores from 7.40 to 8.14, the conventional reduced the spread of scores from 7.13 to 6.73.

Research Question 3: What is the mean achievement scores of male and female students in ecology taught with ICOBIS?

Table 2: Pretest and Posttest Mean of Achievement Scores of Male and Female Students taught Ecology using ICOBIS

Groups	N	Pretest Mean	Posttest Mean	Gain in Mean	Posttest SD	Posttest SD
Male	57	20.79	42.28	21.49	7.43	7.74
Female	33	21.06	41.97	20.91	7.48	8.92

Table 2 shows ICOBIS is effective in enhancing both male and female students' achievement in ecology. ICOBIS increased the spread of scores among females with SD 8.29 than among the males with SD of 7.74.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught ecology with Interpretation Construction-based Instructional Strategy (ICOBIS) and those taught with conventional method.

Table 3: ANCOVA on Significant Difference in Mean Achievement Scores of Students in Ecology taught with ICOBIS and those taught with conventional method

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	3083.879[a]	2	1541.939	28.523		
Intercept	23348.196	1	23348.196	431.894		
Pretest	382.622	1	382.622	7.078		
Methods	2522.172	1	2522.172	46.655	.000	Sig.
Error	9460.503	175	54.060			
Total	273850.000	178				
Corrected Total	12544.382	177				

Table 3 shows that there was a significant main effect of the treatment on the achievement of the students, F (1, 175) = 46.655, P (0.000) <0.05. Thus, the null hypothesis was rejected. Therefore, there is significant difference in the mean achievement scores of students taught ecology with Interpretation Construction-based Instructional Strategy (ICOBIS) and those taught with conventional method.

Hypothesis 3: There is no significant difference in between the mean achievement scores of male and female students taught with ICOBIS.

Table 4: ANCOVA on Significant Difference in Mean Achievement Scores of Male and Female Students in Ecology

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	188.399[a]	2	94.199	1.434		
Intercept	14219.674	1	14219.674	216.502		
Pretest	186.377	1	186.377	2.838		
Gender	2.768	1	2.768	.042	.838	NS
Error	5714.101	87	65.679			
Total	165925.000	90				
Corrected Total	5902.500	89				

Table 4 shows that there was a significant main effect of the treatment which accounted for 3.2 percent of the variance in the achievement scores of male and female students, F (1, 87) = 0.042, P (0.838) > 0.05. Thus, the null hypothesis was not rejected. Therefore, there is no significant difference in between the mean achievement scores of male and female students taught with ICOBIS.

Hypothesis 5: There is no significant interaction effect of teaching methods and gender on students' achievement in ecological concepts.

Table 5: ANCOVA for Interaction Effect between Teaching Methods and Gender on Students' Achievement in Ecological Concepts

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	3108.113[a]	4	777.028	14.246		
Intercept	19739.942	1	19739.942	361.903		
Pretest	365.428	1	365.428	6.700		
Method * Gender	19.668	1	19.668	.361	.549	NS
Error	9436.270	173	54.545			
Total	273850.000	178				
Corrected Total	12544.382	177				

Table 5 shows that there is no significant interaction between gender and teaching methods on the students' mean achievement scores, F (1, 173) = 0.361, P > 0.05. Therefore, the null hypothesis was not rejected. Thus, there is no significant interaction effect of teaching methods and gender on students' achievement in ecological concepts.

DISCUSSION

The finding of this study revealed Effects of Interpretation Construction-based Instructional Strategy (ICOBIS) on achievement scores of students in ecological concepts is significant when compared to that of those taught using conventional method using their pretest posttest mean scores. The improvement in the achievement of students in ecology due to ICOBIS could be attributed to its characteristic group learning. Students in ICOBIS classroom construct knowledge in groups in an attempt to integrate existing knowledge within the new experiences. Thus, as Brook (2004) noted, students in ICOBIS classroom learn on the premise that by reflecting on their experiences in groups, learners interpret and construct their understanding of the world they live in especially as it relates to ecology.

Interpretation construction based instructional strategy (ICOBIS) according to Black and McClintock (2006) has seven components which include: observation; interpretation construction; contextualization; cognitive apprenticeship; collaboration; multiple interpretation; and multiple manifestation. Thus, students also collaborate in observing, interpreting, contextualizing and gain cognitive flexibility by being exposed to multiple interpretation and lastly, gain transferability by seeing multiple manifestations of the same interpretations. These consequential effects of ICOBIS in turn improve the students' achievement. The findings of this study lends credence to the findings of Akin and Karplus (2016) who demonstrated that ICOBIS based instructional strategy has the potential of improving students' learning of science concepts. The study of Cambel (2015) supports the findings of this study as the researcher noted that students in ICOBIS based instructional strategy performed better than their counterparts in the lecture method. The findings of this study supports that of Gerogon (2005) who reported that ICOBIS instructional strategy improved students' learning of biological concepts.

Biology concepts like ecology deals with organisms and their interaction with their environment. Students to be able to engage in meaningful understanding of ecology would have to relate experience gained in the classroom to what obtains in the real environment. Teachers in using ICOBIS based instructional strategy laid emphasis on active roles of learners in the process of constructing their own knowledge by working with other students in groups. By so doing, students gained better understanding of concepts through peer interaction. Students learning are challenged by the experience of others in their immediate group leading to discarding of wrong ideas and retention of the right concepts. It is in this context that students properly conceptualized the ecological concepts taught in this study which enhanced their achievement more than their counterparts in the lecture group.

The findings of this study showed that effect of ICOBIS on the achievement scores of male and female students in ecological concepts do not differ significantly using their pretest posttest mean scores. There is no significant interaction effect between gender and teaching method on students' achievement in ecological concepts. The findings of this study is in agreement with the findings of Nwagbo and Obiekwe (2010) who reported that no significant difference existed between the achievement of male and female students taught with ICOBIS. In ICOBIS, one of the key principles that form the foundation is group work in which students collaborate in pairs and small groups. Learning in groups enables students to engage in meaningful discussion and observe and learn from one another.

CONCLUSION

The findings of this study revealed significant positive effect of interpretation construction based instructional strategy on students' achievement in ecology. The conclusion is that ICOBIS based instructional strategy enhances students' achievement in ecology significantly and is not gender sensitive.

RECOMMENDATIONS

The following recommendations are made in the light of the findings of the study:

1. Biology teachers should adopt the use of interpretation construction based instructional strategy in teaching ecological concepts. Seminars and special training should be organized for biology teachers by the government in order to familiarize them with the use of ICOBIS approach to teaching and learning.
2. Biology teachers should arrange classroom setting in such a way as to facilitate collaboration among students when teaching ecological concepts.

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