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# Enhancing Secondary School Students' Academic Performance in Biology Through Instructional Scaffolding

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**ABSTRACT**

This study focused on enhancing secondary school students' academic performance in Biology through instructional scaffolding. The study adopted the quasi-experimental pre-test, post-test control group design. Two research questions and two research hypotheses guided the study. The population of the study was all Biology senior secondary school I (SS I) students in government-owned co-education public schools in Ogidi education zone of Anambra state (3, 584).The study comprised 113 senior secondary form I students, randomly selected from four (4) public coeducational schools. The instruments used for data collection was Amobi Uchenna Biology Performance Test (AUBPT) adopted from West Africa Examination Council (WAEC) past questions from (June 1999-June 2015) with reliability of .070 using kuder Richardson formula. Data obtained were analysed using mean, standard deviation for the research questions and Analysis of Covariance (ANCOVA) for hypotheses. The result showed that instructional scaffolding teaching strategy significantly enhances students' performance in Biology concepts. Gender was not a significant factor in the students' performance although the female students achieved better than the males. Based on these, the following recommendations among others were made: science teachers and Biology teachers in particular should employ instructional scaffolding strategy in the classroom so as to enhance the achievement of students' in Biology concepts. Curriculum planners, administrators / policy makers, Ministry of Education in partnership with other professional bodies like STAN should regularly organize workshops, seminars and conferences for trainee and serving teachers to acquaint them with the use of these innovative activity-based teaching strategies specifically, instructional scaffolding strategy.

**Keywords**: Biology, Performance, Instructional scaffolding and Scaffolding theory (ST)

## Introduction

The main objective of Biology Education in Nigeria is to enable the Nigerian child observe and explore the environment and develop basic skills in Biology. The emphasis is on acquiring functional knowledge of Biology concepts and principles that will help the child understand simple natural phenomena and develop appropriate scientific attitudes which include curiosity, critical reflection and objectivity (Karura et al 2021). The child should be able to apply skills and knowledge gained through Biology Education in solving everyday problems in his or her environment. This is in agreement with the broad goals of secondary school education which is to prepare individuals for useful living within the society (Federal Republic of Nigeria, 2013).

Furthermore, Biology as one science subject offered by both science and art students in secondary is a prerequisite science subject for many fields of learning that contribute immensely to the technological growth of any nation especially in the field of forensic science, medicine, agricultural sciences, dentistry, biotechnology which includes genetic engineering, nursing, medical laboratory science among others (Samuel & Obikezie, 2020).

Despite the importance of Biology in national development and its popularity among students, academic performance in the subject is not been encouraging (Araoye, 2010). Researchers like Akinjide (2018) and Ihekwoaba et al (2020) blame the poor performance in Biology on a number of factors such as inadequate learning facilities, inappropriate use of teaching method, over loaded curriculum, poor mastery of language of instruction (English language),poor knowledge of the concepts, lack of qualified teachers and over populated classes among others. Similarly, Etokeren & Okwelle (2019) is of the view that the cause of poor academic performance in Biology general is conceptual difficulty. The authors further asserted that students generally experience difficulties in understanding some difficult Biology concepts. Difficult Biology concepts are those concepts in Biology which students find difficult to learn. One aspect of senior secondary school Biology curriculum that students find difficult to understand is ecological concepts (Arayo, 2010). The above assertion was supported by Chief examiners' report 2018 – 2020.

The reports has it that the causes of students weaknesses and poor performance in Biology subject in the above years was as a result of (i) inability to explain why a Rhesus negative man should not marry a Rhesus positive to avoid losing her second pregnancy (ii) poor grasp of genetics (iii) not given title to diagrams (iii) poor diagrams (iv) inability to cross the genetics questions properly (v) poor performance in questions that require application knowledge (vi) inability to identify the samples skeleton parts (vii) poor knowledge in cell structure and functions of the cell (viii) poor knowledge in forms in which living cell exist (ix) Basic ecological concepts, Ecosystem: components and sizes, (xi)Local biotic communities or biomes: tropical rain forest, Northern guinea savanna, sahel, desert, (xii) Population studies by sampling method: population size, dominance, density, factors that affect population and (xiii) inability to indentify concept in ecological factors: aquatic, terrestrial and factors common to all habitats. According to WAEC the

Chief examiners' for these years, the major weaknesses and difficulties come in the areas of ecology concepts. The reason for these difficulties may be either that the students lack the framework to deepen their understanding of the concepts or the use of ineffective teaching methods in teaching the concepts (Obikezie et al, 2022).

Over the years, efforts have been made by researchers, government and non-governmental organizations in seeking ways of improving students' learning outcomes in this subject. This is because poor intellectual functioning and academic performance in Biology subject is known to culminate in other problems which can be detrimental to the economic, social and political development of the nation (Demirci & Duzenli 2017). Obikezie et al (2022) in support of the above assertion emphasizes that poor quality performance in ecological concepts of Biology fields is later transferred to the occupational sectors of a nation's economy.

Okolocha and Nwaukwa (2020) viewed academic performance as degree of knowledge and skills exhibited by students in a subject designed by test scores assigned by the teacher. The authors stated that Biology academic performance is usually measured by tests scores and expressed in a grade or units based on students' achievement in the subject which can only be obtained maximally by innovative instructional strategy. Omwirhiren and Ibrahim (2016) opined that there are many kinds of innovative instructional strategies that have help in greater academic performance in Biology and other science subjects. Examples of such are generative learning instructional strategy, think- pair share instructional strategy, computer based assisted instructional strategy, and self regulated learning strategy, instructional scaffolding e.t.c.

George et al (2021) observed that Chemistry students taught with generative learning innovative instructional strategy performed better than those taught with lecture method by so there was a significance difference from those taught with generative learning innovative instructional strategy and those taught with lecture method in favour of Chemistry students taught with generative learning innovative instructional strategy. The authors further asserted that there was a significant difference in academic performance between male and female students taught Chemistry using generative learning innovative instructional strategy in fovour of female students in Onitsha education zone of Anambra state Nigeria. Karura et al (2021) observed that students taught Christian religion education using think pair share instructional strategy performed better than students taught the same subject using demonstration strategy in east Africa. The authors maintained that there was a significant difference in academic performance between students taught with the two instructional strategies in favour of think pair share but there was no significant difference among students who are taught the subject using think pair share. Similarly, Omwirhiren and Ibrahim observed that there was a significant differences in academic performance among students taught Biology using think pair share than those taught with lecture method in northern Nigeria. The authors maintained that differences could be as results of pair interaction which occurs while using think peer instructional strategy in teaching and learning. Akinjide (2018) revealed that there is no significant difference in academic performance between Biology students taught with conventional instructional strategy and those taught with innovative instructional strategy. The author further stated that by so doing, there was no significant difference in academic performance among male and female Biology students when the two instructional strategies are used in southern Nigeria. On a contrary Umuoke and Nwafor (2014) maintained there is a significant difference in academic performance among male and female students when they are taught Biology using instructional scaffolding in Enugu state Nigeria in favour of male students. The authors stressed that the reason may be as a results of ability of male students to work together than their female counterpart. Similarly, Uche et al (2022) revealed that self regulated learning strategy significantly enhanced students' academic performance in Biology compared to the lecture method. The authors further observed there was no significant difference between the mean performance score of male and female students taught Biology using self regulated learning strategy but there was a significant difference in mean interest score of students taught using self regulated learning strategy and those taught using lecture method. Also the authors asserted there was no significant difference between the mean interest score of male and female students taught Biology using self-regulated learning strategy in Onitsha education zone of Anambra state Nigeria. Most of the studies reviewed above were done in other innovative instructional strategy other than instructional scaffolding. Even the one done in instructional scaffolding was done in Enugu state which is not part of the present scope of study. On this note the researchers investigated if instructional scaffolding will enhance secondary school students' academic performance in Biology.

Instructional scaffolding is based on Vygotsky's zone of proximal development (ZPD). ZPD is that field between what a learner can do by himself (expert stage) and what can be achieved with the support of a knowledgeable peer or instructor (pedagogical stage) (Ellis & Worthington,1994). Vygotsky believed that a child could be taught any subject efficiently using scaffolding practices by implementing the scaffolds at the ZPD.As students gain control of these new learning, the teacher withdraws the support gradually until finally, the learner is able to complete the task or master the concepts independently (Chang et al.,2002). Such teaching and learning strategy is not in line with the traditional view of learning like lecture method that emphasizes computations and verbal presentation of knowledge.

Instructional scaffolding is supported by scaffolding theory (ST). Scaffolding theory (ST) was first introduced in the late 1950s by Jerome Bruner a cognitive psychologist. This theory identifies the importance of providing students with enough support in the initial stages of learning a new subject. Scaffolding Theory ST emphasis that students need many opportunities to learn with the teacher and more skilled peers. That is to say those Biology teachers serve as facilitators and guides while more capable peers serve as tutors. The Biology teacher lends various levels of assistance over various repetition of task completion depending on the cognitive level of the student. with all these numerous importance of ST, the researchers chooses the theory because it offers a framework for providing supports that enable students to deal with more complex content and skill demands that they could otherwise handle alone and thus tries to find out if instructional scaffolding will enhance secondary school students' academic achievement in Biology in Ogidi education zone of Anambra state.

## Purpose of Study

The main purpose of the study is to ascertain enhancing secondary school students' academic performance in Biology through instructional scaffolding. Specifically, the study investigated:

1. The mean performance scores of students taught Biology concepts using instructional scaffolding strategy and those taught using lecture method.
2. The mean performance scores of male students taught Biology concepts using instructional scaffolding strategy and female students taught using the same method.

**Research Questions**

The following research questions guided the study:

1. What are the mean performance scores of students taught Biology concepts using instructional scaffolding strategy and those taught using lecture method?
2. What are the mean performance scores of male students taught Biology concepts using instructional scaffolding strategy and female students taught using the same method?

## Research Hypotheses

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

1. There is no significant difference between the mean performance scores of students taught Biology concepts using instructional scaffolding strategy and those taught using lecture method.
2. There is no significant difference between the mean performance scores of male students taught Biology concepts using instructional scaffolding strategy and female taught using the same method

## Methodology

The design adopted for the study was quasi– experimental research design. The sample consists of 113 SS 1 Biology students selected from Ogidi education zones. Simple random sampling technique was used to draw two co-educational public secondary schools from the 26 co-educational public secondary schools in Ogidi Education Zone. One of the Schools was assigned as the experimental group (24 male and 31 female) the other was assigned as control group (29 male and 29 female) using flip of a coin. The criteria being that the schools must have presented candidates for West African Senior School Certificate Examination (WASSCE) for at least three times. Secondly, the school must have a qualified Biology teacher with at least five years experience. The study covered a period of five weeks. First week was for familiarizing visit and training of the Biology teachers in the selected schools who act as research assistants. First day of the second week was used to administer a pretest achievement test of the Biology students involved in the study. Second day of the second week was used to teach the Biology ecology concept in both selected schools for experimental groups using instructional scaffolding (IS) and control group using lecture method (LM) for three weeks. The Biology teachers were given detailed information and instructions concerning the study. The teachers in both groups used lesson plan prepared by the researchers for both the experimental (IS) and control groups (LM). At the end of the fifth week, both experimental IS and control group LM were post tested base on what they are taught. Marks were awarded to each question prepared for both experiment test group and control group achievement test which constituted fifty (50) questions. If all the questions were answered correctly by the student, his/she is entitled to hundred (100) marks. The pretest score as well as post test scores in both IS and LM group in each sitting had 100 marks. The pre test scores were recorded as achievement of the students in both groups. Post test scores were recorded as achievement of the students when taught with IS and LM in both groups as well. Data collected was used for analysis.

## Instrument

The instrument for data collection was designed by the researchers named Amobi Uchenna Biology Performance Test (AUBPT) which was adopted from West Africa Examination Council (WAEC) past questions from (June 1999-June 2015).

The AUBPT was produced base on the Biology concept of ecology concept. To ensure the reliability of the instrument, the fifty (50) objective achievement questions were administered on a group of twenty students outside the place of this study. The results were subjected to Kuder 20 Richardson. A mean coefficient of 0.74 was obtained indicating that the instrument was reliable. The date obtained from the pretest and post test were analyzed using mean, standard deviation for research questions and Analysis of Covariance (ANCOVA) to test the hypotheses.

## Result

The result of this study was presented in line with the research questions and the hypotheses as follows.

***Research Question 1***

What are the mean performance scores of students taught Biology concepts using instructional scaffolding strategy and those taught using lecture method?

**Table 1 pretest and posttest performance mean and standard deviation scores of Biology students taught with Scaffolding Instructional Strategy and those taught with lecture method**

| | | Pretest | | Posttest | |
|---|---|---|---|---|---|
| Treatment | No | X | SD | X | SD |
| Scaffolding | 55 | 67.05 | 12.47 | 129.92 | 13.35 |
| Lect Meth | 58 | 65.65 | 13.44 | 91.48 | 11.98 |

Table 1 shows a mean performance pre-test score of 67.36, with a standard deviation of 12.40 for students that were taught Biology using instructional scaffolding while their counterpart taught the same Biology concept using lecture method have mean achievement pre-test score of 65.65, with standard deviation of 13.44. As for the post-test, students taught Biology using instructional scaffolding had a mean performance score of 129.92 and a standard deviation of 13.35 while their counterparts taught with lecture method had a mean score of 91.48 with a standard deviation of 11.98.

***Research Question 2***

What are the mean performance scores of male students taught biology concepts using instructional scaffolding strategy and female students taught using the same method?

**Table 2 pretest and posttest performance mean and standard deviation score by gender of Biology students taught with scaffolding instructional strategy and those taught with lecture method**

| | | Pretest | | | | Posttest | |
|---|---|---|---|---|---|---|---|
| Treatment | Gender | No | X | SD | | X | SD |
| Scaffolding | Male | 24 | 29.25 | 8.08 | | 60.83 | 6.87 |
| | Female | 31 | 37.80 | 6.39 | | 69.09 | 6.46 |
| Lect Meth | Male | 29 | 30.34 | 7.44 | 43.93 | 6.81 | |
| | Female | 29 | 35.31 | 6.00 | | 48.55 | 5.17 |

Table 2 shows that mean performance pre-test scores of male and female are 29.25 and 37.80, with a standard deviation of 8.08 and 6.39 respectively for students that were taught Biology using instructional scaffolding while their counterpart taught the same Biology concept using lecture method had mean performance pre-test scores of 30.34 and 35.31, with standard deviation of 7.44 and 6.00. As for the post-test, male and female students taught Biology using instructional scaffolding had a mean performance scores of 60.83 and 69.09. That of standard deviation are 6.87 and 6.46 while their counterparts taught the same Biology concept with lecture method had a mean score of 43.93 and 48.55 with a standard deviation of 6.81 and 5.17.

***Hypothesis 1***

$HO_1$ There is no significant difference between the mean performance scores of students taught Biology concepts using instructional scaffolding strategy and those taught using lecture method.

**Table 3: Two-way Analysis of Covariance (ANCOVA) of Students' Achievement score by Treatment and Gender**

| **Source** | **Dependent variable** | **Type 111 sum of squares** | **Df** | **Mean square** | **F** | **Sig** |
|---|---|---|---|---|---|---|
| Corrected Dec. | posttest | 15407.66a | 4 | 3851.91 | 612.494 | .001 |
| Intercept | | 3564.96 | 1 | 3564.96 | 566.86 | .001 |
| Pretest | | 3713.87 | 1 | 3713.87 | 590.54 | .001 |
| Treatment | | 9184.36 | 1 | 9184.36 | 1460.40 | .001 |
| S Gender | | 13.65 | 1 | 13.65 | 2.17 | .144 |
| NS Treatment*gender | | 2.77 | 1 | 2.77 | .441 | .508 |
| NS Error | | 679.20 | 108 | 6.289 | | |
| Total | | 365544.00 | 113 | | | |
| Corrected total | | 16086.86 | 112 | | | |

a. R squared= .958 (Adjusted R squared =.956)

Table 3 presents computations on Biology performance dependent variable (Test of Between- subjects Effects at 0.05level of significance). A significant effect was observed for treatment, F (1,108) =1460.40, $p$<0.05. Therefore hypothesis 1 which was stated in the null form is rejected in favour of the

alternative hypothesis. Also looking at the mean in table 1, instructional scaffolding has a posttest mean of 65.49 while lecture method has a posttest mean of 46.24. Hence, instructional scaffolding is considered more effective than lecture method in teaching Biology concepts.

***Hypothesis 2:***

$HO_2$: There is no significant difference between the mean performance scores of male students taught Biology concept using instructional scaffolding strategy and female taught using the same method.

Table 3 reveals that gender was not a significant factor on students' overall performance scores on posttest. F (1,108) =2.17, *P*>0.05. Therefore, the null hypothesis 2 was not rejected. This means that female students' Biology performance is not significantly different from that of the males.

***Discussion***

The results of the study were discussed under the following sub-headings:

The effectiveness of instructional scaffolding strategy on students' performance in Biology concepts.

The influence of gender on students' performance in Biology concepts.

***The Effectiveness of Instructional Scaffolding Strategy on Students' Performance in Biology Concepts***

The study revealed that the use of instructional scaffolding strategy as a teaching method was a significant factor in students' overall performance in Biology concepts since F (1,108) =1460.40, $p<0.05$. The result further showed that the mean performance scores in AUBPT were higher with experimental group (65.49) than control group (46.24). This significant difference is attributed to the treatment and must have stemmed from the fact that students were involved in the entire activity of the learning process as instructional scaffolding requires active participation of the students.

In teaching with instructional scaffolding strategy, the teacher provides the students with cognitive support when new topic is being taught; this support is withdrawn as the students show evidence of learning so that they learn independently. The teacher acts as a guide or coach while more capable peers serve as tutors to help students as they struggle with tasks they cannot quite accomplish on their own, and this interactions between the teacher and students enables the students develop new cognitive abilities. Hence, the topic being learned has a greater chance of being integrated into the cognitive structure of the students.

Teaching science subject especially Biology with innovative instructional strategy like instructional scaffolding strategy has improved students' conceptual knowledge, intelligence as well as their general academic performance. This is in line with Chang et al., (2002) believe that a child could be taught any subject efficiently using scaffolding practices by implementing the scaffolds. This plays a fundamental role in cognitive development and subsequently enhances academic performance of the students. In affirmation of the above statement, the studies carried out by George et al (2021) believe that Chemistry students taught with generative learning innovative instructional strategy performed better than those taught with lecture method. The findings of the present study is consistent with those of Karura et al (2021), Omwirhiren and Ibrahim (2016), Uche et al (2022) and Umuoke and Nwafor (2014) who in their separate studies found that the use of innovative instructional strategies like think pair share, self regulated learning strategy and instructional scaffolding strategy as a teaching method greatly enhance students' academic performance.

Contrarily to the findings is the report of Akinjide (2018) revealed that there is no significant difference between Biology students taught with conventional instructional strategy like lecture method and those taught with innovative instructional strategy like instructional scaffolding. The difference in the findings between the studies could be due to difference in location, time and population.

***The Influence of Gender on Students' Achievement in Biology Concepts***

This study reveals a non significant gender related difference in the students' performance in Biology since F (1,108) = 2.17, $p>0.05$. However, the female students with mean 59.17 outperformed their male counterparts who recorded a mean of 51.58. The issue of gender and in performance in science subjects has remained controversial among science educators despite the fact that gender is one of the factors suspected to interact with performance. While some researchers (Umuoke and Nwafor 2014) found that male students achieve better than females, George et al (2021) maintained that reverse is the case, yet others like Akinjide (2018) and Omwirhiren and Ibrahim (2016) posited that there is no significant difference in gender performance just as the present study. Hence, all students benefitted equally irrespective of gender.

## Conclusion

Based on the findings of the study and observations made by the researcher**,** the following conclusions were drawn; Instructional scaffolding teaching strategy can improve Biology performance in secondary school students since the experimental group taught with instructional scaffolding strategy had higher mean achievement score in Biology concepts used in the study. The influence of gender on the students' performance in the Biology concepts studied was also not significant, although the female students taught with instructional scaffolding performed better than their male counterparts.

***Recommendations***

The researcher formulated the following recommendations based on the findings and conclusions made from the study:

1. The administrators/ policy makers likewise should provide adequate learning environment and necessary support for advancement of teachers on pedagogy (instructional strategies) and software especially in their in service/ preparatory programmes.
2. Biology teachers should inculcate in their students the attitude of embracing activity oriented and student centered learning approach. This will enable the students' carryout independent or group work such as assignment and project given to them, which provides room for better cognitive integration and retention of knowledge.
3. Both teachers and parents should also encourage students' to be serious with their group project and assignments while studying with instructional scaffolding and other activity oriented methods as this could improve their communication and collaborative skills as well as interpersonal relationship.

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