Promoting Students' Academic Achievement on Difficult Biology Concepts Using Context-Based Instructional Method: Implication for Reducing Depression Among Students

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Abstract

Poor achievement of students in Biology, as reported by the West African Examination Council chief examiner in 2022 and 2023 in Nigeria, as well as the fluctuating trend in the achievement of Biology students over the years, necessitate the need for the present study. The study adopted the quasi-experimental design using the pretest-posttest non-equivalent control group design. The study was guided by three specific purposes and hypotheses, with a population of 673 senior secondary two (SS2) biology students. The sample size of 120 participants (M=55; F=65) was drawn using a simple random sampling technique. Data were collected with a validated Biology Achievement Test (BAT) that has a reliability value of 0.93, determined using K-R21 Mean and standard deviation were used to answer the research questions, while ANCOVA was used to test the hypotheses at 0.05 significant level. Results show that students taught difficult biology concepts with a context-based instructional method outperformed those taught with the conventional lecture method. The difference in the mean achievement scores of male and female students was not significant and there was also no significant interaction effect of teaching method and gender on students' achievement in biology.

Keywords: Context-based instructional method, Achievement, Difficult biology concepts

INTRODUCTION

Biology is a branch of natural science that studies living things, such as plants and animals, that exist in microscopic and macroscopic forms. It equips students with robust knowledge, transferable skills, and a desirable attitude, which they bring to bear for the development of the society where students find themselves. Hence, its teaching is both formal and informal, and it is orchestrated by its immense importance to the individual and the nation at large. In Nigeria, the teaching of biology is built on a well-planned curriculum with robust content geared at attaining the needs and values of the Nigerian nation. The curriculum has many valuable topics, which are divided into four themes that are spirally arranged across the levels of senior secondary schools, both in the formal and informal system of learning. These themes are the organization of life, organisms at work, the organism and its environment, and continuity of life (NERDC, 2009). It is anticipated that exposing students to the aforementioned biology themes will equip them with the necessary laboratory and field skills, meaningful and pertinent knowledge, the capacity to apply scientific knowledge to everyday issues pertaining to agriculture, health, and personal and community issues, as well as a

reasonable and practical scientific attitude (NERDC, 2009). Thus, the study of biology helps students to choose careers in medical sciences, nursing, biological sciences, and teaching, among others, through which they become socially responsible and contribute to the growth and development of a given society (Udeani et al, 2016). The relevance of biology validates the need for its study and improvement of students' academic achievement.

Students' academic achievement in biology entails students attaining the curriculum objectives to which they are exposed during instructional processes. Academic achievement connotes the degree to which students achieve educational goals (Ampofo & Osei-Owusu, 2015; Agboghoroma & Oyovwi, 2015; Martin et al, 2017; Abbasi & Izadpanah, 2018; Tadese et al, 2022). The authors report that it is one of the criteria for determining a student's success in the contemporary society. Consequently, students, teachers, policy-makers, government, parents, and other stakeholders are concerned about the academic achievement of students (Kahu & Nelson, 2017). Despite the relevance of biology, it was reported that students' performance in biology in 2022 and 2023 was generally poor in Nigeria. The

situation is not different in the Igbo-Etiti Local Government Area of Enugu State, where there was a fluctuating trend in students' performance in the biology external examination. Some of the reasons associated with poor performance, as reported, are poor use of teaching methods, insufficient resources, curriculum contents, and the abstract and interdisciplinary nature of biological concepts (Manishimwe et al., 2023). Interestingly, biology is perceived by students as having an abstract concept and, therefore, difficult to understand. In order to help students acquire the procedural skills necessary to investigate and comprehend nature and the biological processes occurring around them, the instruction focuses on giving them firsthand experience (Salu, 2015).

Difficult biology concepts are those concepts or topics that the students do not easily understand. Some of these concepts or topics are nutrient cycling in nature, ecological management, pests and diseases of crops, conservation of natural resources, reproductive system in plants, nutrition, cell structure, variation, and genetics, among others (Etobro & Fabinu, 2017; Wan et al., 2021). Research also reported that this abstract nature of science itself, including biology, where students seem not to relate what they learn to their

immediate environment, as well as teaching methods, are the causes of students' difficulties in learning some concepts in biology (Manishimwe et al., 2023). While the biology curriculum is quite suggestive of how it could be taught, it was recommended that the contents be contextualized or context-based (NERDC, 2009). Hence, the need for the adoption of a context-based instructional method.

A context-based instructional method relates the curriculum content to the students' environment. It is a teaching approach that relays the curriculum contents that students are expected to learn in an instructional process to their environment, culture, or experiences for meaningful learning (Okereke & Nzewi, 2020). The approach associates learning contents with the physical surroundings of the learners alongside artifacts and other resources that are obtainable in such an environment. It recognises the integration of a learning method such as blended which research shows that It improves student involvement, comprehension of biological concepts, and the growth of science process abilities (Cartono, 2023). It makes an effort to explain learning materials using ideas and abilities from everyday life circumstances or cultures that students are familiar with and find relevant

(Anthony et al, 1998; Rose, 2009; Kazeni & Onwu, 2013). The context-based instructional method involves learning by doing, reviewing knowledge through examples from the nearest environment, and developing reasonable connections among concepts or topics (Opara & Oguzor, 2011; Coban, 2013; Gercek & Ozcan, 2015). Thus, the context-based instructional method could be participatory since students actively find a link between their culture and the learning concept (Eshetu & Assefa, 2019). Scholars have acknowledged the efficacy of innovative learning methods in enhancing students' academic performance (Yapici, 2016; Yaki, 2019; Margunayasa et al, 2019; Kyado et al, 2019; Agyei, 2022; Onowugbeda et al, 2023; Umar, 2024). Research shows that compared to students exposed to the Conventional Teaching Strategy, those exposed to CCMIS achieved noticeably higher mean achievement levels in BAT (Athuman, 2017). It is believed that teachers could diversify the contexts in biology learning by including common cultural practices, situations, and stories, among others, within the ambit of learners' experiences (Kazeni & Onwu, 2013). Nworgu (2009) maintained that analogies drawn from students' cultural backgrounds during biology lessons are usually more meaningful to them.

Accordingly, research, especially in education, has shown that gender is a common variable that influences students' learning outcomes. It is the characteristics of women, men, girls, and boys that are socially constructed (WHO, 2024). Studies on gender appear to be inconclusive. For instance, Odagboyi (2015) reports that male students had higher mean achievement scores in biology than female students when taught with teaching methods such as jigsaw. Nwosu and Ibe (2014) reported that girls are not less intelligent than boys. Nwosu (2015) encouraged science teachers to make use of gender-friendly approaches and instructional strategies when teaching their lessons across schools. It was also reported that male and female students taught using CCMIS did not differ significantly in achievement (Kyado et al, 2019). Could a context-based instructional method be gender friendly while attempting to reduce the abstract nature of some biology topics to improve students' achievement? This question has become central in the present study, following the passion most learners exhibit for being nature-friendly. Considering that various studies have been conducted in different locations, the present study tends to add to existing literature on the efficacy of such methods while establishing its novelty, especially in

Igbo-Etiti Local Government Area of Enugu State with unique cultural heritages. The findings of this study could provide valuable insights into the potential of innovative teaching methods in improving student outcomes.

Theoretical Framework of the Study

The study was anchored on the social constructivism theory (Vygotsky,1962). The theory emphasizes the collaborative nature of learning whereby knowledge or learning is influenced by learners' interaction with one another, their culture, and their environment. Vygotsky emphasized that language and culture play indispensable roles in human intellectual development. The present study is rooted in this theory since learners' learning during instructional processes is linked to their environment or culture. Consequently, connecting students' learning to the cultural contexts is believed to break the barriers in the learning of biology and science generally. Thus, the context basis of biology teaching could be advantageous because it:

- Enables the learners to understand the new lesson within the context of their culture.
- Closes the abstraction gap some students experience when biology concepts/lessons are delivered to them in the classrooms or laboratories.
- Makes biology concepts relevant.

- Enables students to understand the relationship between what they learn in school and the larger society.
- Fosters the transfer of learning to out-of-school situations that epitomize meaningful learning.
- Encourages the active participation of learners in the instructional process
- Enhances effective teacher-learner, learner-learner, and learner-community resource interactions that are useful for meaningful learning.
- Encourages students to ask questions and inquire about the cultural connection of the new learning, which helps to develop their communication and social skills.

With these advantages, the teacher is seen to cover a large amount of curriculum content within a short time using the conventional lecture method. This method encourages a one-way flow of information from the teacher (who is more experienced) to the learners. It is commonly used by teachers across schools during instructional processes (Shah & Campus, 2021). Despite the short period in covering a large amount of content, studies have demonstrated the effectiveness of a context-based instructional method on students' achievement, attitude, interest, and motivation (Kazu et al ,2014; Okebukola et al., 2016; Cabbar & Şenel, 2020; Abdulsalam et al., 2020).

Purpose of the Study

The study aims to determine the effect of a context-based instructional method on students' academic achievement in difficult biology concepts and its implication for reducing depression among students. Specifically, the study ascertains the following:

1. Achievement scores of senior secondary school students who were taught difficult biology concepts using a context-based instructional method and those who were taught using the lecture method.

2. Gender effects on biology students' achievement.

3. Gender and teaching methodology's combined impact on biology students' achievement.

Research Questions

The following research questions guided the study:

1. What is the mean achievement scores of senior secondary school students taught difficult biology concepts using context-based instructional method and those taught using lecture method?

2. What is the influence of gender on students' achievement in biology?

Hypotheses

The following null hypotheses tested at 0.05 significant level guided the study.

Ho_1: There is no significant difference between the mean achievement scores of senior secondary school students taught difficult biology concepts using context-based instructional method and those taught using lecture method.

Ho_2: Gender has no discernible impact on biology students' academic achievement

Ho_3: Gender and instructional strategies do not significantly interact to affect biology students' academic achievement.

METHOD

Research Design

The pretest-posttest non-equivalent control group type was used in the study's quasi-experimental design. Because entire classes were used, the design was deemed suitable for the research. Therefore, participants were not completely randomized into treatment and control groups. Rather, the experimental and control groups were randomly assigned to intact courses (Nworgu, 2015).

Study Area

The study was conducted in the Igbo-Etiti Local Government Area of Enugu State, which has a rich cultural heritage. Among the colorful cultural heritages are the Odo masquerade, "Ahajioku," and Mgboko-Odobo festivals (Nwani, 2024). Nwani further stated that Igbo-Etiti is bounded by the

Nsukka Local Government Area in the North, the Isiuzo Local Government Area in the East, the Udi and Enugu East in the South, and the Uzouwani Local Government Area in the West. Farming, trading, palm wine tapping, woodwork, and craftsmanship, among others, are the major economic activities in the area. This area was chosen because of the variation in students' achievement in biology.

Population of the Study

The population of the study was 673 secondary senior (SS) 2 biology students consisting of 295 males and 378 females for the 2023/2024 session.

Sample and sampling Technique

The 120 SS2 students in four complete classes from four randomly selected public coeducational secondary schools in the area—55 male and 65 female biology students—made up the study population. The following actions were taken in 13 public secondary schools that were coeducational. First, numbers were assigned to each school on slips of paper, then, the slips were placed into a container and shuffled thoroughly. After the shuffling, four slips were selected one after another without replacement. Finally, the schools corresponding to the drawn slips were selected and used for the study.

Instrument for Data Collection

The instrument for data collection was the researchers-developed Biology Achievement Test (BAT).

Validation and Reliability of the Instrument

Three specialists from the Department of Science Education at a university in Negeria's Biology Education and Measurement and Evaluation Units face-validated the tool.Its content validity was taken care of using a table of specifications. The reliability of the test instrument was determined after a trial-testing using 30 SS2 Biology students in another local government area different from the area of the study but sharing similar characteristics in terms of being in the same education zone, using the same Biology curriculum and wrote the same uniform examination to mark the end of every academic session. The scores obtained were subjected to Kuder Richardson (K-R21), which yielded an internal consistency reliability value of 0.93.

Experimental Procedure

Prior to the commencement of the study, ethical approval was granted to the researchers by the University of Nigeria Nsukka Ethical Committee. In addition, the consent of all participants was sought by the researchers and had the research process and objective clearly explained. Thereafter, four research assistants who

were biology teachers in their respective schools were trained by the researchers. Two teachers in the experimental group were trained on the use of a context-based instructional approach. In contrast, the other two in the control group were informed to use the conventional lecture method. The participants were given a pretest as initial observation before the treatment began. Students in the experimental (treatment) group were taught five lessons drawn from the biology curriculum, among which were skeleton and supporting systems in animals, using a context-based instructional approach. The teacher, after dividing the students into four mixed groups based on gender, introduced the lesson by relating skeleton and supporting systems in animals to the traditional or modern houses in the students' environment that have wooden or iron supports or pillars, which, if removed, will lead to the collapse of the building. This explains the need for skeletons in animals. After the introduction, the teacher guided the students in their groups towards learning the lesson content. Students in the control group, who were also in four mixed groups, were taught the same five lessons using the conventional lecture method without relating the lessons to the culture or learners' environment. After the treatment, a posttest was administered to the students. In conducting the study, some extraneous variables, such as situational variables and the Hawthorne effect that might have a confounding effect on the results, were controlled.

Data Analysis Techniques

SPSS version 22 was used to score and quantitatively evaluate the obtained data. The study issues were addressed using mean and standard deviation, and the null hypotheses were tested at the 0.05 level of significance using analysis of covariance (ANCOVA).

RESULTS AND DISCUSSION

Table 1. Mean and standard deviation of the achievement scores of senior secondary school students taught difficult biology concepts using context-based instructional and those taught using lecture method

| Group | N | Pretest | | Posttest | | Mean Difference |
		Mean (X)	SD	Mean (X)	SD	
Control	59	9.12	1.94	21.53	3.19	12.41
Experimental	61	8.80	1.78	26.00	3.57	17.20

From the Table 1, the pretest mean achievement and standard deviation scores for students in the control group taught difficult Biology concepts using the conventional lecture method are (M=9.12, SD=1.94), while the pretest mean achievement and standard deviation scores for those in the experimental group taught difficult biology concepts using context-based instructional approach are (M=8.80, SD=1.78). The post-test mean achievement and standard deviation scores for students taught difficult Biology concepts using the conventional lecture method are (M=21.53 and SD=3.19). In contrast, the post-test mean achievement and standard deviation scores for students taught difficult Biology concepts using the context-based instructional approach are (M=26.00, SD=3.57). The mean difference between the post-test and pretest scores was 12.41 and 17.20, which is indicative that students in the experimental group performed better than those in the control group.

Table 2. ANCOVA showing difference between the mean achievement scores of senior secondary school students taught difficult Biology concepts using context-based instructional approach and those taught using lecture method

Tests of Between-Subjects Effects						
Dependent Variable: Posttest						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared (η^2_p)
Corrected Model	665.032[a]	4	166.258	14.820	.000	.340
Intercept	2059.607	1	2059.607	183.584	.000	.615
Pretest(covariate)	49.009	1	49.009	4.368	.039	.037
Group	634.456	1	634.456	56.553	.000	.330
Gender	18.190	1	18.190	1.621	.205	.014
Group * Gender	.202	1	.202	.018	.893	.000
Error	1290.168	115	11.219			
Total	69928.000	120				
Corrected Total	1955.200	119				
a. R Squared = .340 (Adjusted R Squared = .317)						

Result in Table 2 shows that F(1,115) = 56.553, p = 0.000 < 0.05, η2p= 0.330). The null hypothesis is thus rejected because the associated probability value of 0.000 is less than the significance level of 0.05. In addition, the effect size (η2p= 0.330) shows that a 33 percent variance in students' achievement in Biology was attributed to the treatment (giving a context-based instructional approach). Consequently, the Table indicates that students taught

difficult biology concepts using context-based instruction significantly improved their achievement in biology compared to those taught difficult biology concepts using conventional lecture methods.

Table 3. Mean and standard deviation showing the influence of gender on students' achievement in Biology

Group	Gender	N	Pretest Mean ($\overline{X}$)	SD	Posttest Mean ($\overline{X}$)	SD	Mean Difference
Control	Male	25	9.16	2.07	21.04	2.65	11.88
	Female	34	9.09	1.87	21.88	3.52	12.79
Experimental	Male	30	8.97	1.73	25.70	3.72	16.73
	Female	31	8.64	1.84	26.29	3.46	17.65
Total	Male	55	9.05	1.88	23.58	4.00	14.53
	Female	65	8.87	1.85	23.98	4.11	15.11

Result in Table 3 shows that male students taught difficult biology concepts with context-based instructional approach had pretest of (M=8.97, SD=1.73) and posttest of (M=25.70, SD=3.72), while the female had the pretest of (M=8.64, SD=1.84) and posttest of (M=26.29, SD=3.46). The mean difference between the posttest and pretest scores: were 16.73 and 17.65 showing that when taught challenging biology concepts through a context-based teaching strategy, the experimental group's female students outperformed the group's male counterparts.

Furthermore, the influence of gender on students' achievement in biology showed that male students had a pretest of (M=9.05, SD=1.88) with a posttest of (M=23.58, SD=4.00), while the female students had a pretest of

(M=8.87, SD=1.85) and posttest of (M=23.98, SD=4.11). The mean difference between the posttest and pretest scores were 14.53 and 15.11 showing that the female students achieved better than their male counterparts in Biology.

Results shown in Table 2 concerning the influence of gender on students' achievement in Biology revealed that $(F_{(1,115)} = 1.621, p = 0.205 > 0.05, \eta2p = 0.014)$. With the associated probability value of 0.205 greater than the 0.05 level of significance; the null hypothesis two is hereby not rejected. In addition, the effect size ($\eta2p = 0.014$) shows that gender influence was found to

be responsible for 1.4% of the variation in biology students' performance. Therefore, it can be concluded that when biology is taught utilizing a context-based instructional approach, gender has no discernible effect on students' performance. Results in Table 2 on the interaction effect of teaching approach and gender on students' achievement in Biology revealed that ($F_{(1,115)} = 0.018$, $p = 0.893 > 0.05$, $\eta 2p = 0.000$). Null hypothesis four is thus not rejected because the corresponding probability value of 0.893 is higher than the 0.05 level of significance. The interaction graph in Figure 1, where the lines do not connect, serves as another example of this.
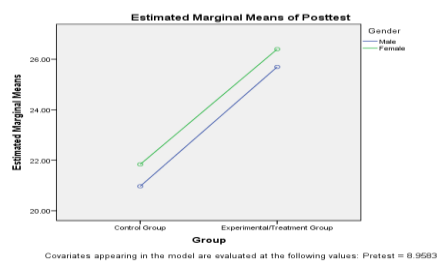

Figure 1. Interaction graph of teaching methods and gender

Discussion

The findings indicate that the context-based teaching strategy outperformed the traditional lecture method in encouraging students to master challenging biology subjects. This study supports the findings of Okebukola et al (2016) that a context-based approach is effective in improving students' achievement in difficult Biology

concepts. The improved achievement observed could be because Biology students felt at home and deemed such Biology concepts relevant when they are related to their culture or immediate environment. Thus, reducing the abstract nature of the concept, while reducing the phobia tendency with an increase in the learners' attention towards learning the lesson contents meaningfully. However, in using students' cultural background or immediate environment as connections for new learning, an effort is made by the teachers to use common ones known by the students for better understanding and possible transfer of learning. The findings uphold Vygotsky's theory which emphasized that language and culture play indispensable roles in human intellectual development and in how humans learn or perceive the world. The idea of employing the learners' culture during instructional processes was amplified by Okebukola (2020) that teachers are encouraged to make their teaching of biology concepts meaningful and less foreign by linking the learning contents to the context of learners' environment and cultural background. The present study therefore adds to existing literature on the usefulness of learners immediate environment in explicating perceived difficult concepts. In addition, providing empirical evidence on the efficacy of context based

instructional method in delivery difficult concepts in senior secondary schools in developing countries such as Nigeria.

Furthermore, results reveal that the context-based instructional method was not gender biased, Consequently, both male and female students are encouraged to master challenging biology ideas. As the interaction graph explains, four of the female students had a marginally different mean achievement score than the male students, but this difference was not statistically significant. As Nwosu (2015) rightly encouraged science teachers to make use of gender-friendly approaches and instructional strategies when teaching their lessons across schools, the context-based instructional method is said to be among the gender-friendly approaches. Thus, the study acknowledges the validity of the instructional method by both male and female students. By this result, it is believed that the efficacy of the use of context-based instructional methods could be extended to teaching other difficult concepts in other related science subjects across senior secondary schools in Nigeria. This view however is subject to further scientific investigations in future studies in Nigeria.

Implications of the Study

The findings of this study have implications for reducing depression among secondary school students.

Depression or depressive disorder is the loss of pleasure or interest in activities for a long period (WHO, 2023). It causes a persistent feeling of sadness and loss of interest (Sawchuk, 2022). The occurrence of depression brings about sadness, feelings of negativity and worthlessness, poor attendance at school or lessons, poor concentration and avoidance of social interaction among others (Sawchuk, 2022; WHO, 2023). Depression can lead to suicide which is the fourth leading cause of death in school children between the ages of 15 and 29 years old (WHO, 2023). To ameliorate this mayhem, it becomes expedient that the students be helped to feel connected to the school and the environment by building strong relationships (American Academy of Pediatrics, 2024). The use of context-based instructional methods in biology instructional delivery therefore enables the teacher to relate the instructional contents to the students' culture and immediate environment which fosters connectedness to the school through interaction with the teacher, their fellow students as well as with the learning materials. The connection of learning content to the learners' culture or environment as well as the established interaction helps to build confidence in them, hence, reducing phobia that may come as a result of the abstract nature of

some biology concepts, at the same, building a robust social interaction geared towards reducing depression tendencies among the students.

CONCLUSION

The results of the study indicate that the context-based teaching approach is a successful teaching strategy for raising students' proficiency in challenging biology concepts in Nigerian secondary schools. While various scholars attest to the efficacy of the instructional method, sufficient attention has not been given to it in the area of biology in secondary schools in Nigeria. In filling this gap, the present study provides empirical evidence reflecting its relevance. The use of context-based instructional method as an instructional paradigm in teaching difficult concepts, especially in biology which is central to the present study is germane in reducing depression tendencies among secondary school students which in turn brings about improvement in their achievement of the subject. The study acknowledges that though the method was effective, the sample was small to validate the findings across other developing countries. It is also believed that using other moderating variables could significantly alter the interaction effect.

Given these limitations, the study recommended that future research be replicated in other states using a large sample size and other moderating variables to enhance the generalization of the findings. Additionally, it may be beneficial to explore standardized achievement tests in future research. It is also recommended that future studies be applied to difficult concepts in other science-related subjects further to validate the overall efficacy of context-based methods in teaching.

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