

EFFECT OF CONTEXT-BASED LEARNING ON STUDENTS' ACADEMIC ACHIEVEMENT IN SENIOR SECONDARY SCHOOL BIOLOGY

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ABSTRACT

Biology is one of aspects of science that study living things in their environment and is an on-going science process that allows scientists and students to conduct scientific investigations which are very useful in discovering new things. However, students' achievement is not encouraging. Researchers have therefore pointed out the need for the adoption of student-centred instructional strategies to address this problem. Literature have recognized the use of many strategies in enhancing students learning outcomes in other science subject but few studies have been carried out on students' academic achievement in biology using context-based learning. This study, therefore, examined the effect of context-based learning on secondary school students' academic achievement in biology in Lagos State. The moderating effect of gender was also investigated. The research design is a pretest-posttest non-equivalent control group quasi-experimental design. Two schools were selected from the Kosofe Local Council by random sampling. Four intact classes of SS1 students were selected from each of the schools. A total of 294 students participated in the study. Students were randomly assigned to context-based learning and control group. The study lasted for 5 weeks. The Biology Achievement Test (BAT) research instrument was used for the study. The reliability of the instrument was established using the Kuder-Richardson Formula 20 (KR-20) which produced a reliability coefficient of **0.713**. Two null hypotheses were tested at 0.05 level of significance. Analysis of covariance and Scheffe post hoc test were used to analyses data. The ANCOVA result revealed a significant effect of treatment on students' academic achievement in biology, $F(2, 459) = 341.45, p < .001$, with a large effect size, partial $\eta^2 = .598$. The two-way interaction effect of treatment and gender on student learning outcomes was not significant. Context-based learning enhances students' academic achievement. Context-based learning strategies should therefore be adopted in teaching of biology in senior secondary school.

KEYWORD: Academic Achievement, Biology, Context, Context-based learning.

Introduction

Biology is one of vital science subjects which provide contents, skills and habit of mind in the training of students who want to study science- related careers. Learning of biology is very important to secure a well-paid job in many science- related careers such as nursing, agriculture, pharmacy. Also, biologists desire and strive to understand how the world work following a systematic methodology based on evidence. The purpose of teaching and learning science is to master the basic principle of biology, as well as organizing the scientific method that is based on scientific attitude to solve problems and to understand the natural world (Suryawati and Osman 2018).

It is extremely important for schools to develop students' understanding. Understanding is at the basic level of cognition. If students are well -nurtured with the basic level of cognition, they will not have difficulty in reaching higher cognitive level (Kamulzanan et al, 2017). Understanding is therefore a vital factor in achieving learning outcomes such as academic performance which is one of the ultimate learning outcomes in science education. Abebe (2024) defined conceptual understanding as having a deep flexible and justified grasp of the basic scientific principles, aptitudes and generalizations with rich links and connections, as well as being able to use and apply them to different domains of environmental science. Conceptual understanding improves retention because students who understand concepts are more likely to retain information and remember it when needed.

Academic achievement can be defined as students' test score as measured by the grades obtained. Performance in science course including biology can be early predictor of students' interest to pursue further in science related field. When students understand science concepts and perform well, they may stay motivated to study science. However, conventional method of teaching, traditionally based lecture and expository methods focus on transmission of excessive out- of- context information to students (Abebe 2024). Cabbar and Senel (2020) noted that students generally study out of context topics for examination .Students may likely forget abstract information since they are not given opportunity to actively engage with learning activities which may leads to lack of conceptual understanding. Ural (2020) revealed that transmitting scientific facts with fewer

activities is not enough to develop conceptual understanding. According to Fikadu et al (2019), lack of conceptual understanding may undermine students' performance in procedural understanding test. Lack of conceptual understanding has really weakened students' performance in Nigeria secondary school in biology. Researches have shown that academic achievement of biology students over the years in science subjects remain discouraging and inconsistency in the senior certificate examination (WAEC 2018, 2019, 2020, 2021, 2022). The table below shows inconsistent performance of students across all the three science subjects biology, chemistry, and physics in the May/ June 2014-2022 West African Senior School Certificate Examinations in Nigeria.

Table 1: Performance of students in the May/June 2014-2022 West African Senior School Certificate Examinations for biology, chemistry, and physics in Nigeria

Year	Biology total sat	credit pass	% pass at credit level	Chemistry total sat	credit pass	% pass at credit level	Physics total sat	credit pass	% pass at credit level
2014	1,365,384	766,971	56.17	636,268	397,649	62.49	635,729	386,270	60.76
2015	1,390,234	798,246	57.42	680,357	412,323	60.60	684,124	410,543	60.01
2016	1,200,367	740,345	61.68	706,873	408,122	57.74	705,125	415,655	58.95
2017	580,449	394,898	68.03	377,970	320,632	84.83	377,851	205,757	54.45
2018	1,087,063	679,299	62.48	728,551	424,231	58.22	728,354	571,687	78.49
2019	1,003,304	775,103	75.01	726,132	566,156	77.96	725,853	565,746	77.94
2020	1,051,447	874,237	84.08	756,101	674,361	89.89	755,772	634,400	84.61
2021	1,039,912	913,463	89.23	769,642	649,535	85.44	768,613	663,949	87.44
2022	1,057,577	699,430	66.69	806,579	527,433	65.78	805,948	502,172	62.65

Unsuitable teaching method and strategies like conventional method of teaching, traditionally based lecture and expository methods have been identified as one of the factors that contribute to students' poor performance (Oladipo & Akhigbe, 2022). Science education profession has a direct responsibility to make male and female students equally fulfil their cognitive potential in science. Science education also works toward anti-bias teaching. Gender equity means ensuring all students of all sex have full opportunity to become successful science learner. Science education believes that all gender identity is valid. Gender equity is essential to the advancement of science and to the achievement of science literacy. Gender refers to the social/cultural construct, characteristics and roles which are ascribed to male and female in any society. Gender stereotyping is a collection of commonly held beliefs about what are appropriate characteristics, behaviours and activities for male and for female in any society. Abuh (2021) revealed that traditional learning environment greatly encourages gender stereotyping because of role and activities ascribed to male and female students in the classroom. The roles which are ascribed to male help them in the learning process and academic achievement while female are excluded in the learning activities which make them experience discouragement. This may lead to poor academic achievement. Kang (2022) reported that recent studies keep indicating that girls possess a lower interest in science compared to boys.

Context-based learning is one of the constructivist approaches that can improve students' performance. Context-based learning is a method of teaching where context is used as a teaching strategy to provide background information to adequately illustrate biology topics. Context can be used as background information to illustrate, gives meaning, illuminates and explains concepts in biology. Cabbar and Senel (2020) noted that in teaching, context helps to examine the situation of the concepts and to present it from different aspects of relationship. Context makes abstract concepts relevant so that the relevance between

daily life and the concepts will be experienced by the students. CBL changes the role of student and teacher by placing students' activity at the centre of teaching process (Bacay and Herrera, 2020). The teaching environment in this way is seen as a stimulating factor for students for effective learning and understanding

Context-based learning is a learning technique that enables the transfer of knowledge by associating the subject covered by the teacher with daily life. Associating subject with daily life has an important place in developing understanding of science course (Karasubasu, 2023). Abebe (2024) noted that context-based learning encourages group work which allows students share ideas, opinion listen to what others will say and gain collective knowledge. Gaining collective knowledge can impact students' performance positively. Cabbar and Senel (2020) noted that connecting an abstract topic with daily life will increase the permanence of information. Context-based teaching approach used in the study comprising of Orientation, Elicitation of ideas, Restructuring of idea, Application of idea and Review change in ideas.

Phase 1: Orientation

The introduction of real-life situations as orientation to learners was meant to provide a reason for teaching new scientific concepts) and to provide a setting of real-life experiences.

Phase 2 Elicitation of ideas

Engage students in question-and-answer sessions to establish student previous knowledge and alternative ideas.

Phase 3 restructuring of idea

Construction of new ideas and evaluation.

Phase 4: Application of idea

In the final phase, learners were given tasks that required them to apply the concepts they had learned to already discuss situation at the orientation stage and new situations. The tasks involved applying content learnt to in resolve science related problem.

Phase 5: Review change in ideas

The phase was further intended to provide educators with feedback on the effectiveness of the learning cycle in enhancing conceptual understanding.

Based on the WAEC chief examiner report showing inconsistent academic performance of students in biology, especially in some selected topic like ecology, it is necessary to investigate the effect of context based learning on biology students' academic achievement in biology probably this would improve the academic achievement of students in biology.

Statement of the Problem

Researches have shown that academic performance of students over the years in science subjects remain discouraging and inconsistency in the senior certificate examination (WAEC 2018, 2019, 2020, 2021, 2022). When students perform poorly, they may no longer stay motivated to study science. Hence, there is need to investigate the effect of context-based learning on biology students' academic performance in carbon cycle.

The specific objectives of the study

1. Examine the effect of context-based learning and the conventional lecture method on students' academic achievement in biology.
2. Examine the interaction effect of context-based learning and gender on students' academic achievement in biology.

Research Questions

Based on the stated objectives, the following research questions were raised to guide the study:

1. What is the effect of treatment and conventional lecture method on students' academic achievement in biology?
2. What is the interaction effect of treatment and gender on students' academic achievement in biology?

Research Hypotheses

The study tested two null hypotheses at 0.05 % level of significance in the study:

Ho1: There is no significant effect of context-based learning on students' academic achievement in biology

Ho2: There is no interaction effect of context-based learning and gender on students' academic achievement in biology

Methodology

The study adopted a pretest-posttest, non-equivalent control group, quasi- experimental design. Treatment group is context-based learning while the control group is conventional lecture method. Dependent variable includes students' academic achievement in biology.

Participant

The participants in the study are biology students selected from two public co-educational senior secondary schools in educational district 2 Lagos State. Context based learning consists of 148 students from four intact classes while the control group consists of 146 students from four intact classes. The students in experimental group were taught using context-based learning, while those in control group were exposed to the conventional lecture method of teaching.

Instrument for data collection

Instruments used for the study is Biology Achievement Test (BAT). BAT was prepared by the researcher through the objectives of the topics of carbon cycle, air pollution and oxygen-carbon balance. Questions related to carbon cycle, air pollution and oxygen-carbon balance were adopted and modified from Programme for International Student Assessment (PISA) and United State Environmental Protection Agency, (US EPA) archive document on carbon through the season lesson. The test comprises 30 questions. It was administered to students during pre-test and posttest. It was administered to students during pre-test and posttest. Biology achievement test is in seven sections. Section A was used to obtain information about students' biodata; section B -G comprises of open-ended questions in biology for students. Test contents cover the concepts of carbon cycle and air pollution and oxygen and carbon balance in four levels of cognitive domain of remembering, understanding, applying and creating. The instrument consisted of 30 short-answer test items designed to assess students' academic performance in biology. Each item was dichotomously scored (1 = correct, 0 = incorrect), making the obtainable scores range from 0 to 30. The reliability of the instrument was established using the Kuder-Richardson Formula 20 (KR-20), which produced a reliability coefficient of 0.713. This indicates that the BAT has an acceptable level of internal consistency and is suitable for use in this study.

Validation of the instruments

The content validation was carried out by biology experts in the science education department, experienced biology teachers in secondary schools and colleagues in the field of biology. The items were also validated using table of specification to ensure adequate distribution of test items across the specified cognitive objectives. This is also to ensure the tests items representativeness of the major content area: carbon cycle, air pollution and oxygen-balance are in line with the specified objectives. The three major content areas of the topics covers four levels of cognitive taxonomy which are remembering, understanding, applying and creating. In addition, the face and content validation of the instrument was done by experts in the field in order to ensure that it measures what it intends to measure.

Experimental Procedure

Experimental procedure consists of three stages, the pre-test, and implementation of the learning task and the administration of post-test. The pre-test was conducted in the first week. The researcher administered research instrument to experimental groups and the control group during the first week. After the pre-test the students were exposed to the instruction and learning activities which lasted for three weeks .The experimental group was exposed to context-based learning, while the control group was exposed to the conventional lecture method. The treatment administration lasted for three weeks. At the end of the administration of treatment, all the students took post-test in all the study lasted for five weeks.

Result

Research Question 1: What is the effect of treatment and conventional lecture method on students' academic achievement?

Ho1: There is no significant effect of treatment on students' academic achievement

Table 1: Descriptive Statistics of Students' Learning Outcomes in Biology by Treatment

Treatment	Learning Outcomes	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean gain
CBL148	AAB	3.24	2.401	16.51	5.679	13.27
CLM146	AAB	3.57	2.831	4.99	2.669	1.42

Based on Table 1 both CBL is more effective in improving students' academic achievement in biology compared to the CLM with CBL showing the greatest improvement.

Table 2: Analysis of Covariance on the Effect of Treatment on Students' Academic achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	17450.898 ^a	3	5816.966	302.855	<.001	.664
Intercept	12685.182	1	12685.182	660.442	<.001	.590
BAT Pretest	3287.673	1	3287.673	171.170	<.001	.272
Treatment	13116.673	2	6558.336	341.454	<.001	.598
Error	8816.065	459	19.207			
Total	106108.000	463				
Corrected Total	26266.963	462				

R Squared = .664 (Adjusted R Squared = .662)

The ANCOVA results (see Table 2) reveal a significant effect of treatment on students' academic achievement in biology, $F(2, 341.45, p < .001$, with a large effect size, partial $\eta^2 = .598$.

Table 3: Bonferroni Post-hoc Analysis on the Effect of Treatment on Students' Academic achievement

Treatment (I)	Treatment (J)	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	Lower Bound	Upper Bound
CBL	AIS	.707	.505	.487		-1.920	13.066
	CLM	11.836*	.512	.000		10.606	13.066
AIS	CBL	-.707	.505	.487		-1.920	.506
	CLM	11.129*	.502	.000		9.923	12.335
CLM	CBL	-11.836*	.512	.000		-13.066	-10.606
	AIS	-11.129*	.502	.000		-12.335	-9.923

Based on estimated marginal means: *. The mean difference is significant at the 0.05 level. b. Adjustment for multiple comparisons: Bonferroni.

Post-hoc Bonferroni analysis (Table 3) shows that students exposed to Context-Based Learning (CBL) performed significantly better than those taught using the Conventional Lecture Method (CLM), with mean differences of 11.84 which is significant at $p < .001$.

Research Question 2: What is the interaction effect of treatment and gender on students' academic achievement?

Ho2: There is no significant interaction effect of treatment and gender on students' academic achievement

Table 4: Descriptive Statistics of Treatment Interaction with Gender on Students' academic achievement

Treatment	Learning outcomes	Gender	Mean	Std. Deviation	N
CBL	AAB	Male	15.70	6.065	74
	AAB	Female	17.31	5.181	74
CLM	AAB	Male	4.77	2.936	65
	AAB	Female	5.17	2.438	81

Table 4 indicate that female students achieved higher academic achievement across all treatment.

Table 5: Analysis of Covariance on the Interaction Effect of Treatments and Gender on SAA

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	17553.094 ^a	6	2925.516	153.093	.000
Intercept	12532.065	1	12532.065	655.808	.000
BAT Pretest	3181.390	1	3181.390	166.483	.000
Treatments	12925.987	2	6462.993	338.211	.000
Gender	45.656	1	45.656	2.389	.123
Treatment * Gender	49.302	2	24.651	1.290	.276
Error	8713.869	456	19.109		
Total	106108.000	463			
Corrected Total	26266.963	462			

a. R Squared = .668 (Adjusted R Squared = .664), BAT = Biology Achievement Test

The ANCOVA results in Table 5 revealed that there is no significant interaction effect between treatment and gender on students' academic achievement in biology ($F = 1.290, p = .276$). However, treatment has a significant effect ($F = 338.211, p < .001$), indicating that the instructional method has effect on students' scores. Gender alone has no significant influence achievement ($F = 2.389, p = .123$), though pre-test scores are significant covariate ($F = 166.483, p < .001$). The R^2 value of .668 suggests that approximately 67% of the variance in post-test academic achievement is explained by the model, mainly driven by the treatment differences rather than gender or their interaction.

Discussion

Effect of Treatment on Students' Academic Achievement in Biology

Context-based learning (CBL) has a significant effect on students' academic achievement in biology compared to conventional lecture method. Students in context-based learning experimental group perform better than the students in the conventional lecture method in the biology achievement test. This is in line with the work of Karasubasi and Hatice, (2023) which revealed that context – based learning has a significant effect on Turkish students' science academic achievement. In addition, Akinsola, Okebukukola and Oladejo, (2022) finding revealed that CBL has a significant

difference impact on students' academic achievement in biology has a positive effect on motivation as well as academics success. Esra & Figen (2015) revealed that CBL improves biology learner performance because narrative contexts tied to their everyday lives help students in learning biology. Students are more receptive to stories and stories are easier to remember. Students could recall story, consider the principle contained inside and make connection to their concepts, teamwork, and discussion research assisted. Abebe (2023) also noted that relating students' experiences and concepts can help students better understand biological concepts. In addition, another reason for success in CBL over conventional lecture method of teaching might be because students learn in group and this give students chance to share ideas and opinion , listen to what others have to say, support each other and gain collective knowledge (Abebe 2023). Research evidence revealed that teacher's usage of inefficient way of teaching instruction to teach transmitted knowledge could be linked to science student's poor academic performance in conventional lecture method of teaching (Adunola 2011).

Interaction Effect of Treatment and Gender on Students' Academic Achievement in Biology

The result revealed there is no significant interaction effect of treatment and gender on students' academic achievement in biology. Eshetu and Assefa (2019) revealed that CBL causes increment in the mean scores of both male and female students. Sunday, Olaoye and Audu (2021) findings show that there is no significant difference between the mean achievement scores of students; taught in geometry with contextual teaching strategy and those taught with conventional method. There is no significance different between the mean achievement score of male and female students taught geometry with CTS. The success of male and female students in context-based learning may be due to interaction of context that is common to all students into teaching and learning process. Fikadu et al (2019) reported that interaction of context that is common to all students in teaching and learning process engage male and female in a variety of learning activities is valuable for both male and female students. The issues of gender and student's academics achievement in science remain controversial issues.

Conclusion

Context based learning used in this study have been found to improve students' academic achievement in biology. Context based learning is a suitable strategy that can improve male and female academic achievement in biology.

Educational Implications of Finding

The significant effect of context-based learning used in this study has been found to improve students' academic achievement in biology. This is because these methods allow active participation of students during teaching and learning process. Teachers also engaged students actively by providing series of learning activities such as the use of context, group discussion, given reason while engaging in scientific explanations. It could be used as alternative to conventional method to improve students' learning outcomes.

Recommendation

Based on the findings of this study, the following recommendations are expedient:

1. Biology Educator should embrace context-based learning as teaching and learning strategy to improve students' learning outcomes because according to Sangoleye et al (2022) teachers are responsible for translating of theory into practice in the classroom.
2. Teachers should be trained on the use of context-based learning
3. Curriculum developer should arrange the topic in the curriculum and make of context, pictures, charts, more of girls' pictures in the textbooks; various learning activities that will cater for male and female students should be provided. This can enhance equitable opportunities for all students to acquire full knowledge of subject matter.

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