

Effect of Combined Instructional Techniques on Learners' Academic Achievement and Practical Skills in Biology in Ibadan

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Abstract

In Nigeria, persistent poor academic achievement of learners in Biology had been observed in both theoretical and practical aspects over the years. This has been attributed to learners having poor understanding of Biological concepts and principles and its application as a result of the traditional method of teaching (Lecture method) commonly by employed teachers which reflects on learners' lack of understanding of the subject. Thus, every effort must be made to ensure that learners understand the concepts and principles in order to be able to apply them in all learning situation and their daily living. Therefore, a combined instructional technique (Analogy-Scaffolding) was examined. A pretest-posttest control quasi-experimental design was employed. This study used a random sampling in selecting one educational zone out of two educational zones in Ibadan and purposive sampling was used in selecting two co-educational schools and an arm of SS 2 science intact class each school was used totalling 50 learners. Four validated and standardized instruments were used: Achievement Test in Biology (ATB) ($r = .76$), Biology Practical Skill Test (BPST) ($r = .86$), Analogy and Scaffolding instructional technique guide and conventional instructional technique guide. Four hypotheses were tested at $p = 0.05$. The data analyses used were mean, standard deviation and analysis of co-variance. The findings show that learners' academic achievement was high in analogy-scaffolding group ($x = 16$, $SD = 0.9$) while conventional group was low ($x = 2.06$, $SD = 0.59$) [$F(1,46) = 234.672$, $p < 0.005$]. The practical skills of analogy-scaffolding group was also high ($x = 26.60$, $SD = 7.71$) while conventional group was low ($x = 3.32$, $SD = 0.61$) [$F(1,46) = 110.969$, $p < 0.05$]. The analogy-scaffolding instructional technique and academic achievement and practical skills were significant. Gender was not statistically significant ($x = 9.04$, $SD = 4.56$) and ($x = 15.70$, $SD = 13$ and ($x = 8.96$, $SD = 5.46$ and ($x = 14.28$, $SD = 9.96$) respectively. It was recommended that the combined active instructional techniques which deal with theoretical and practical aspects should be encouraged and adopted during teaching/learning of Biology.

Keywords: Analogy-Scaffolding group, Conventional group, Gender, Instructional Technique, Practical Skills, Academic achievement

Introduction

Biology is a very essential and intriguing subject that affects different aspects of human life. It deals with the natural world, plants and animals, diseases, cure and treatments. Biology comprises theory and practical. These two aspects complement each other; the theoretical aspect has some abstract concepts in which the practical aspect helps in making the abstract concepts concrete and understandable. Based on evidences from West African Examination Council (WAEC), it was revealed that there had been persistent poor performance of students in Biology in Senior Secondary School. The results of students in Biology in Senior Secondary School Certificate Examination

conducted by the West African Examination Council (WAEC) in 2006 - 2013 provide evidence of not very impressive academic performance of students in Biology. The percentage of students who were in the category of A1-C6, on the average, was below 50%. The best year was 2013, when the number of students who were in the category of A1-C6 was 51.66%. The implication of this is that it was only in 2013 that 51.66% students who sat for the examinations were qualified to seek admission into tertiary institutions of learning, to read medical sciences, nursing, agricultural science, education science and some other science related courses while in other years less than 50% were qualified.

More importantly, in WAEC Chief Examiners'

Report (2012), it was reported that candidates' have poor knowledge of practical such as drawing skills, mathematical skills, logical presentation of practical results among others. The students' poor performance could be as a result of some factors such as teacher factors, student factors, parental factors among others but this study focused on one of the teacher factors which is teaching instructional techniques.

The teaching method commonly employed by teachers is conventional teaching method (Lecture method but there is need for teachers to adopt and adapt various teaching instructional techniques such as brainstorming method, inquiry-based learning method, problem-solving based learning method among others that will make the students participate actively during teaching/learning process. Research (Adesoji & Ibraheem, 2009) shows that these methods are capable of sustaining the interest of the learners. Therefore, inappropriate instructional strategies have been identified as the underlying factor for poor learning outcomes in science.

National Teachers' Institute (NTI, 2012) states that in order to make science easy and enjoyable for students to learn, the teacher should pay close attention to the facts that learning involves active participation of the learner. This can be achieved by making students work in groups and share materials while the teachers coordinate them and provide guidance. However, such activities should be useful and meaningful to the students. This is because students learn best if the activities they participate in are seen as useful to them in real life. Also, it is believed that no student comes to class completely blank. This means that students make meaning of what the teacher teaches by comparing it to what they already know or believe in.

In literature, the use of two or more teaching methods has been advocated for, for effective teaching/learning. This study combined analogy and scaffolding instructional techniques. Some researchers suggest that every method has its deficiencies when used singly. Based on this knowledge, analogy and scaffolding teaching method were combined in this study so that

deficiencies in each can be compensated for in students' understanding of Biological theory and practical and as well help to alter their alternative conceptions of the two Biological aspects. However, conventional teaching method was not also left out in this study. Summarily, instructional strategies play a significant role on students' academic achievement. Apart from this, another important factor is gender.

Gender is a word that differentiates masculinity and femininity. There is no gainsaying the fact that gender could be a factor in some cognitive areas. Therefore, there is need to explore how combined instructional techniques (Analogy-Scaffolding) and gender can determine learners' academic achievement and practical skills.

Theoretical Background

This study is based on Schema and Scaffolding theories. These two theories are basically constructivist theory. Constructivism is a theory about "knowing and learning". Constructivist theory view learners as actively engaged students in teaching/learning process. Native American folktales Frederic Bartlett (1886 – 1969) noticed that many of the recalls were not accurate, but involved the replacement of unfamiliar information with something more familiar. Analogy is based on Scheme theory. Analogy instructional technique is when the teacher links between the known and knowledge, that is, the link between the analogue/source and target. Analogies make for vividness and easy understanding of abstract concept (Amechi, 1995). Schema theorists argue that whenever a child assimilates new information, it will insert its own ideas into what it perceives as reality and also, for effective learning, teachers can refer to existing schema when introducing new learning objectives.

Lev Vygotsky (1920 -1930) developed the concept of zone of proximal development (ZPD). Vygotsky believed that educators should help students learn within their ZPD so that they can increase their skills and knowledge without becoming frustrated by things that are currently too difficult for them to accomplish. Scaffolding theory is all about the teacher

helping the students master a task/skill or concept that the students are initially unable to grasp independently. They offer assistance with only those skills that are beyond the student's capability. Hence, this theory emphasised that learners actively construct knowledge and understanding rather than being passive recipient. This theory made us to understand that knowledge is situated and collaborative. Therefore, this study combined analogy and scaffolding instructional techniques in order to make the learners link between the known and the unknown (analogue/source and target) of new concepts and knowledge been taught as well as master concepts/tasks that learners are unable to grasp independently, by offering assistance by a teacher to support learning and as learner moves towards mastery, the assistance or support is gradually withdrawn in order to shift the responsibility of learning from the teacher to the learner.

Hypotheses

- 1) There is no significant effect of treatment on
 - (a) learners' academic achievement in Biology and (b) practical skills in Biology
- 2) There is no significant effect of gender on
 - (a) learners' academic achievement in Biology and (b) practical skills in Biology
- 3) There is no interaction effect of treatment and gender on
 - (a) learners' academic achievement in Biology and (b) practical skills in Biology

Methodology

The study adopted a pretest – posttest, control group quasi-experimental design method. The schematized layout is shown below;

$O_1X_1O_2$ (Experimental group)

$O_1X_2O_2$ (Control group)

O_1 = represents pre-achievement and practical skills test

O_2 = represents post-achievement and practical skills test

X_1 = analogy-scaffolding instructional technique

X_2 = conventional instructional technique (Lecture method)

Participants

This study used a random sampling in selecting one educational zone out of two educational zones in Ibadan and purposive sampling was used in selecting two co-educational schools and an arm of SS 2 science intact class each was used totalling 50 learners.

Instrument

Achievement Test on Biology (ATB)

This instrument consisted of thirty-five item multiple choice test with four options (A, B C and D). The items were derived from five topics in SS1 and SS2 Biology. Initially, there were 60 items and these were pilot tested. The instrument was constructed by the researcher using a table of specification consisting of the first three cognitive domains namely knowledge, Comprehension and Application. The first three cognitive domains were used because the instructional strategies used were based on making students to be knowledgeable, comprehend and apply the concepts/skills taught where necessary. Kuder-Richardson 20 (KR-20) was used to determine the reliability coefficient of the Biology Achievement Test. The item difficulty indices were between 0.45 and 0.75 with discriminating indices between 0.30 and 0.45. The 35 items were selected from the pools of items trial tested. The table of specification shows the final selected items for the multiple – choice test. The reliability coefficient was 0.76. The breakdown of the items is shown in table 1.

The table of specification for the multiple-choice objective questions in Table 1 indicates that forty-eight percent of the questions tested knowledge, twenty-nine percent tested comprehension and twenty-three percent tested application. The correct option attracted a score of 1 while incorrect option attracted a score of 0. The maximum mark obtainable for the multiple – choice part was thirty – five marks.

Table 1: Table of Specification for Biology Achievement Test (Final)

Topic/Objectives	Knowledge 48%	Comprehension 29%	Application 23%	Total
Population, Dominance and Population Characteristics	2	1	1	4
Determination of population size	1	1	1	3
Osmosis and Diffusion	4	3	4	11
Plasmolysis, Haemolysis, Turgidity and Flaccidity	1	1	1	3
Forms and components of skeleton	9	4	1	14
Total	17	10	8	35

3.6.2 Test of Practical Skills in Biology (TPSB)

The instrument was developed by the researcher to measure the extent to which students mastered practical skills (drawing, experimental and numeracy skills) in biology. The test focuses on the drawing, experimental and numeracy skills according to the SS1 and SS2 scheme of work. Test-retest reliability was carried out using Pearson Product Moment Correlation coefficient which gave a value of 0.856 during a two - week period and this was meant to ensure the stability of the scores over that period of time. In mastering the practical skills, three aspects were focused; namely, drawing, experimental and numeracy skills. The students are expected to develop in them these skills. These are as follows;

Drawing skills: The skills to be learned are as follows, drawing of accurate proportion of specimen (not a textbook version), calculation of magnification and usage of appropriate symbol for magnification in Biological drawings, appropriate labelling of all tissues and

relevant structures of Biological drawings, appropriate drawing of lines of Biological drawings, spelling and identification Biological parts and arrangement of labelled parts.

Experimental skills: The guidelines for the experimental skills are as follows; state appropriate title, list the materials needed, state method/procedure without missing steps to avoid inaccurate result, state appropriate observation/s by using all the senses, state detailed result/s and make accurate conclusion/s/inferences.

Numeracy skills: The numeracy skills built in the students by the teacher is by giving the students appropriate/accurate formula and follow each step adequately in order to get accurate answer.

Data Collection

Two trained Biology teachers participated in the study. The Biology teachers were trained by the researcher on how to use the instructional techniques which lasted for one week. A pre-test

of achievement and practical skills were administered in the first week. The treatments lasted for five weeks, thereafter, biology achievement and practical skills tests were administered on the participants as post-test. There were two treatment groups. These were analogy - scaffolding instructional technique group and conventional teaching method group. In analogy- scaffolding group, N= 25 students. The treatment in this group involved teaching the learners for 40 minutes with adequate support system and then allowing them to

practice the gained knowledge. In conventional group, N= 25 students. The treatment in this group involved teaching the participants for about 40 minutes without support system but they were allowed to practice the gained knowledge.

Data Analysis: The analysis was carried out using descriptive (mean and standard deviation) and inferential statistics – Analysis of Covariance (ANCOVA) - treatment: two groups; Gender: male and female).

Results

Table 1: Descriptive Statistics on Academic Achievement in Biology

Treatment	N	Pre- \bar{x} Score (SD)	Post- \bar{x} Score (SD)	\bar{x} Gain
Analogy - Scaffolding Instructional Technique	25	7.20 (3.52)	23.20 (4.42)	16
Conventional Teaching Method	25	6.10 (3.00)	8.16 (2.41)	2.06

KEY: Number in parenthesis represents Standard Deviation

Table 2: Descriptive Statistics on Practical Skills in Biology

Treatment	N	Pre- \bar{x} Score (SD)	Post- \bar{x} Score (SD)	\bar{x} Gain
Analogy and Scaffolding Instructional Technique	25	6.04 (3.44)	32.64 (11.15)	26.6
Conventional Teaching Method	25	4.92 (2.87)	8.24 (2.26)	3.32

Table 3: ANCOVA of Academic Achievement in Biology

Source	Type III Sum of Squares	df	Mean Square	F	Sig
Corrected Model	2877.854 ^a	3	959.285	79.218	.000
Intercept	12322.874	1	12322.874	1.018E3	.000
Pre-Test	14.302	1	14.302	207.777	.000
Treatment	2841.701	1	2841.701	234.672	.000
Stdgender	19.301	1	19.301	1.594	.213
Trmt*Stdgender	31.034	1	31.034	2.563	.116
Error	557.026	46	12.109		
Total	15728.00	50			
Corrected Total	3434.88	49			

a. R Squared = .129 (Adjusted R Squared = .072)

Table 4: ANCOVA of Practical Skills in Biology

Source	Type III Sum of Squares	df	Mean Square	F	Sig
Corrected Model	7477.865 ^a	3	2492.622	37.343	.000
Intercept	20798.868	1	20798.868	311.598	.000
Pre – practical	15.083	1	15.083	1.452	.234
Treatment	7407.077	1	7407.077	110.969	.000
Stdgender	11.157	1	11.157	.167	.685
Trmt*Stdgender	24.708	1	24.708	.370	.546
Error	3070.455	46	66.749		
Total	31438.000	50			

a. R Squared = .041 (Adjusted R Squared = .021)

H₀₁: There is no significant effect of treatment on (a) learners' academic achievement in Biology and (b) practical skills in Biology

Table 1 indicates the summary of \bar{x} and SD of treatments (Analogy-Scaffolding Instructional Technique) and Conventional Teaching Method) are 16 and 2.06 respectively. This implies that analogy - scaffolding group has high mean gain while the conventional teaching method group is low. The difference in mean gain of (16 - 2.06) 13.94 is statistically significant.

Table 3 further revealed that there is a significant effect of treatment on learners' academic achievement in Biology ($F_{(1, 46)} = 234.672$), $p < .05$; therefore, null hypothesis is rejected

Table 2 indicates the summary of the difference \bar{x} and SD between treatments and students' practical. The \bar{x} gains of treatments (Analogy-Scaffolding Instructional Technique group and Conventional Teaching Method group) are 26.6 and 3.32 respectively. This implies that Analogy and Scaffolding Instructional Technique group has high mean gain while the Conventional Teaching Method group is low. The difference in mean gain of (26.6 - 3.32) 23.28 is statistically significant. Table 4 also indicates there is significant effect of treatment on practical skills of learners in Biology ($F_{(1, 46)} = 110.969$), $p < .05$; therefore, the null hypothesis is rejected

H₀₂: There is no significant effect of gender on (a) learners' academic achievement in Biology (b) practical skills in Biology

Table 3 revealed that there is no significant effect of gender on learners' academic achievement in Biology ($F_{(1, 46)} = 1.594$), $p > .05$; therefore, null hypothesis is not rejected.

Table 4 revealed that there is no significant effect of gender on practical skills in Biology ($F_{(1, 46)} = .167$), $p > .05$; therefore, null hypothesis is not rejected.

H₀₃: There is no interaction effect of treatment and gender on (a) learners' academic achievement in Biology and (b) practical skills in Biology

Table 3 indicates that there is no significant effect of treatment and gender on learner's academic achievement in Biology ($F_{(1, 46)} = 2.563$), $p > .05$; therefore, null hypothesis is not rejected

Table 4 further revealed that there is no significant effect of treatment and gender on practical skills in Biology ($F_{(1, 46)} = .370$), $p > .05$; therefore, null hypothesis is not rejected.

Discussion

The findings indicate that analogy - scaffolding instructional technique and academic achievement and practical skills of learners in biology was statistically significant. The result also revealed a high mean gain in experimental group (Analogy - Scaffolding instructional technique group) of learners' academic achievement and practical skills while the control group (Conventional instructional technique group) had low mean gain. Also,

treatment and gender and academic achievement and practical skills of learner did not interact with one another. The finding supports Agboghroma (2005) who claimed that the use of teaching strategies significantly improved the academic performance of students in secondary schools. The finding implies that use of teaching strategies has positive effect on students' academic performance.

The researchers found students' gender and classroom interaction strategies of teaching and learning of mathematics not to be significant. The finding corroborates with Ajaja (2013) states that the combination of students' sex and instructional methods in biology do not have influence on academic achievement. Also, the finding of this study corroborates that of Nwagbo and Chikelu (2011) who revealed that gender and teaching method on students' skill acquisition were not statistically significant. Therefore, treatment and learners' gender on academic achievement and practical skills were not statistically significant.

Conclusion

Analogy-Scaffolding instructional technique positively influenced learners' academic achievement and practical skills in biology. It could be concluded that when appropriate instructional techniques are integrated and well implemented the learners' learning outcomes could be enhanced.

Recommendations

The following are recommended:

- (i) Biology instructors should employ active instructional technique as supplement to the regular conventional teaching method in order to enhance students' learning outcomes.
- (ii) Analogy and Scaffolding instructional

techniques should be encouraged in all senior secondary schools especially giving support to students during teaching/ learning process. This will assist students in improving students' academic achievement and practical skills.

- (iii) The Biology curriculum should be revised to make adequate provisions for the use of combined active instructional techniques.

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