Refocusing Teaching and Learning through Reflection for Students' Conceptual Change in Biology in Secondary Schools in Abeokuta, Nigeria

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Abstract

The study examined refocusing teaching and learning of Biology through reflection for students' conceptual change in secondary schools in Nigeria. The pretest- posttest control group delayed test, quasi experimental design was adopted. The multi-stage sampling procedure was employed. Research instruments used were subjected to face and content validity.Test-retest reliability indices of (r=0.79) and (r=0.89) were obtained. One research question was answered, while three hypotheses were tested at 0.05 level of significance. Data were analyzed using descriptive statistics of mean and standard deviation with inferential statistics of the Analysis of Covariance. Findings revealed that explicit reflective strategy hadsignificant effect on students' conceptual change in biology. The explicit-reflective strategy was found to facilitate students' conceptual change in Biology. Teachers should allow students to reflect on their prior knowledge to erode misconception and facilitate a correct conceptual change in Biology.

Keywords: Refocusing, Reflection, Explicit-Reflective Strategy, Students' Conceptual Change, Teaching and Learning of Biology.

Introduction

The study of Biology in secondary schools and higher institutions of learning provides students with an understanding of the structural and functional composition of man and other living organisms in general and the relationship of these organisms with their immediate environment. Knowledge of biology provides a range of balanced learning experiences through which students develop the necessary scientific knowledge and understanding, acquire skills and processes, positive values and attitudes (Abimbola, 2015). Through the learning of biology, students acquire relevant procedural and conceptual knowledge to help them understand many of today's contemporary issues, and aware of the interconnections between science, technology and society. It has been recognized as one of the subjects, whose knowledge provides solutions to most of the social problems globally (Ibe and Meduabum, 2011).Biology entails the study of various disciplines such as Botany, Zoology, Biochemistry, Plant and Animal Physiology and Anatomy, Genetics among others (Pallai, 2002).

As a result of the complex nature ofbiology as a broad conceptual subject, most studentstend rote learning whereby contributing to misconceptions in the subject matter (Coley, 2015). Students find it difficult to understand many biological concepts due to the use of conventional strategy on the part of the teachers (Abimbola, 2015). According to the West African Examinations Council Syllabus (WAEC, 2015) and the National Examinations Council Syllabus, acquisition of biological knowledge gives the learners adequate ability to apply biological principles to everyday life in matters that are personal, environmental, economic and which relate to community health. Therefore, biology, being one of the science subjects being offered by secondary school students in Nigeria is expected to be effectively taught by well trained and qualified teachers who are versatile in the use of diverse instructional strategies to teach the subject in a way that students will have conceptual understanding of the subject. Kareem (2014) and Ige and Kareem (2012) posited that in order to make the study of biology exciting and relevant, it is important that teachers adopt different instructional strategies which enable students learn biology by reflecting on what they already know before they enter the classroom to gain new experience through inquiry. Furthermore, they assist students develop the abilities to make scientific inquiries; think scientifically, critically and creatively; and solve problems individually and collaboratively in biology (Ogunbameru and Raymond, 2012).

In spite of the importance of teaching and learning of Biology, studies have revealed that most students have poor conceptual understanding of biological concepts; this had been attributed to the use of ineffective instructional strategies (Kareem, 2014). Most teachers still teach their students using the conventional instructional strategy. As a result, students are unable to link what they already know before they enter the classroom to the new knowledge to be gained after instruction (Coley, 2015). Teachers therefore, need to find out what the students know already before coming into the classroom. What the students already know before having an encounter with new knowledge or learning experience is referred to as students' prior knowledge (Abimbola, 2015). Erroneous prior knowledge leads to misconception can really impede learning because students might be unaware that the knowledge they have are wrong, whereby they interpret new experiences through their erroneous understandings and are unable to correctly grasp new information (Ige and Kareem, 2012).

In order to achieve meaningful and permanent learning, misconceptions need to be remediated through the use of effective instructional strategies which could bring about a conceptual change in students over time. This gradual shift from existing

misconception into correct conceptual understanding of scientific concepts is referred to as conceptual change (Abimbola, 2015).Various strategies have been employed in order to identify the patterns of conceptual organization that students possess for various related concepts as established in their cognitive structures; linking existing knowledge with the new knowledge. Some of these strategies include reflective strategies (Kareem, 2014), simplex and cognitive coaching strategies (Arowolo, 2012), concept maps (Novak, 2000) and many more. The afore-mentioned strategies have contributed to students' conceptual change in biology. In order that biology teachers teach effectively, there is need for them to engage students in activities which may trigger students' reflection on their prior knowledge of biological concepts.

Reflective instructional strategies could be described as teaching and learning strategies which stimulate students to use experiences to discover learning themselves through reflection on previous experiences which could result in conceptual understanding and bring about a gradual shift from misconception (Kareem, 2014; Ige and Kareem, 2012). From findings of past studies on the conduct of reflective strategies in science, use of explicit-reflective instructional strategy had been found to enhance students' knowledge of nature of science and provide students with learning outcomes that are more encouraging. Abd-El-khalik and Lederman (2000) and Abd-El-Khalik (2001) used explicit-reflective instructional strategies to promote teachers' nature of science. It has been noted that students come to classroom with their intuitive prior knowledge of biology concepts which could be valid (correct) or invalid (incorrect) compared to the scientific meaning (Abimbola, 2015). Therefore, this paper investigated the effect of explicit-reflective strategy on students' conceptual change in the teaching and learning of biology in secondary schools in Abeokuta, Ogun State, Nigeria.

Statement of the Problem

Teaching and learning of Biology require great efforts on the part of the teachers to make use of effective instructional strategies that could bring about a gradual shift in students' misconceptions to correct conceptual understanding in Biology in senior secondary schools. Several instructional strategies have been used by scholars in previous studies to correct students' misconceptions in order to effect conceptual change in Biology. In spite of efforts made so far, not much success had been recorded as misconceptions are still being noticed among students in the subject. This paper, therefore investigated refocusing teaching and learning of Biology through reflection for students' conceptual change in biology in secondary schools in Nigeria.

Objectives of the Study

The major purpose of this study is:

1. To examine the effect of explicit-reflective instructional strategy in refocusing teaching and learning of Biology through reflection for students' conceptual change in biology in secondary schools
2. To identify the pattern of conceptual change over time in pre-test, post-test and delayed posttest of students taught some biological concepts using explicit reflective instructional strategy and their counterparts in the control group using conventional strategy.

Research Questions

What is the pattern of students' conceptual change over time in pre-test, post-test and delayed post-test based on treatment?

Null Hypotheses

This paper tested the following null hypotheses at 0.05 level of significance:

HO1: Thereis no significant main effect of treatment (explicit reflective instructional strategy) on students' conceptual change in Biology.

Methodology

This study adopted the pretest- posttest control group quasi-experimental delayed test design.

Two schools were randomly selected from each of Abeokuta North and Abeokuta South Local Government Areas of Ogun State to make a total of four schools. One intact class of SSII science students in each of the selected schools being a total of 457 participants were used for the study. Simple random sampling was done in some schools where there are more than one science class. One intact science class was purposively assigned to represent a treatment group in each of the two LGAs. The two treatment groups are experimental group (explicit-reflective strategy) and control group (conventional strategy). The participants in each group in the four selected schools were administered a pretest in the first week before treatment using SPKPBC. The teacher taught the three biological concepts using one strategy per group in each school following the guidelines. The SPKPBC was to identify students' prior knowledge before being taught new knowledge. Teaching lasted for two weeks. The SBCCAS was thereafter re-administered as posttest to measure the pattern of students' conceptual change of the Biology concept taught. A delayed post-test was further administered after two weeks for the two groups without further exposure to treatment, using SBCCAS to determine the students' conceptual change pattern in Biology from pretest to posttest to delayed post-test over time. Data collection lasted four (4) weeks. Data collected were analyzed using descriptive statistics of Means and Standard Deviation.

Inferential statistics of Analysis of Covariance (ANCOVA) was used. Estimated Marginal Means was used to determine the magnitude of performance and the source of observed significance of variables. Graphs were used to interpret data and relevant interaction effects of variables.

Results and Discussion

Research Question

What is the pattern of students' conceptual change over time in pretest, posttest and delayed post-test based on treatment?

Table 1: Table of Summary of Responses to Pre-test, Post-test & Delayed Post-test

No of Test item	Pre-test			Post –test			Delayed Post-test		
	Correct	**Incorrect**	**Not sure**	**Correct**	**Incorrect**	**Not sure**	**Correct**	**Incorrect**	**Not sure**
1	159	91	0	217	26	7	240	10	0
2	119	131	0	169	27	3	233	7	0
3	43	191	0	130	99	11	204	28	1
4	106	144	0	104	135	8	189	51	4
5	43	207	0	142	93	8	193	55	4
6	154	96	0	122	116	12	181	66	3
7	69	181	0	189	50	9	225	24	2
8	103	137	0	225	19	6	231	17	2
9	45	195	0	230	16	4	238	11	2
10	83	172	0	205	38	8	224	26	0
11	95	155	0	168	57	22	202	45	7
12	66	184	0	182	54	20	215	44	5
13	32	208	0	104	118	25	165	80	11
14	60	180	0	165	59	25	197	50	8
15	121	128	0	144	75	21	167	79	17
16	166	88	0	151	77	22	165	79	29
17	125	125	0	116	109	25	137	107	24
18	117	127	0	96	125	28	117	126	31
19	36	214	0	82	131	35	84	151	58
20	83	167	0	138	82	30	122	102	60

Table 1 shows that no student indicated uncertainty (not sure) during the pre-test in all the test items. Their responses were rated either correct or incorrect in all the items. None of the students indicated that they are unsure. However, in the responses to the post-test and delayed post-test, there were students who indicated that they were not sure of the answer to some of the test items. This does not mean that their level of confidence in attempting the items decreased as a result of the treatment. Students had understanding of the demands of the task in each of the items, as a result of the treatment. For instance, as shown in Figure 1 during the pre-test, 214 students chose incorrect option to item19, while respondents to incorrect option reduced to 131 in post-test. The implication of this is that students who could have chosen the wrong options are now aware of what the wrong answer is, but not certain of what the right is. Although they are not able to choose the right answers consistently, except for item 6 under the concept of photosynthesis which states that carbon (iv)oxide and chlorophyll are end products of photosynthesis. In the pre-test, students gave definite answers.

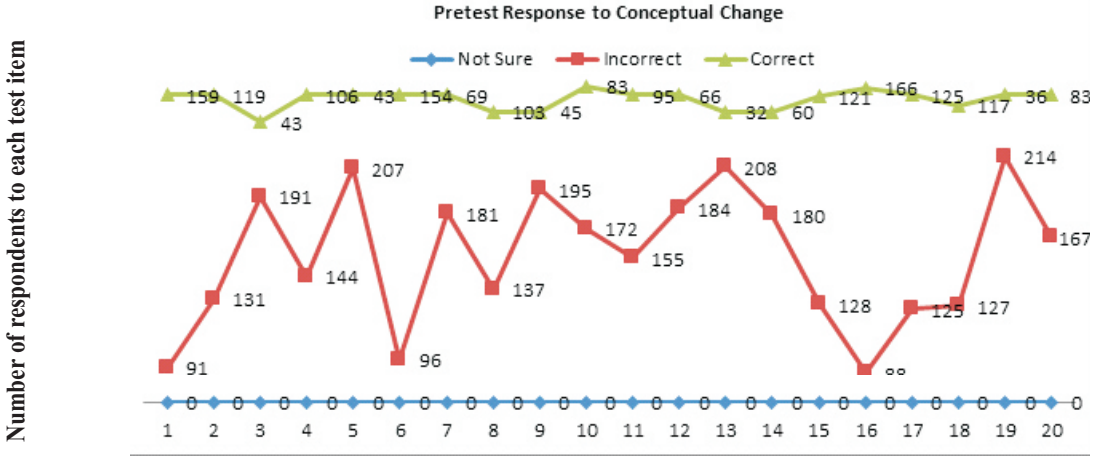
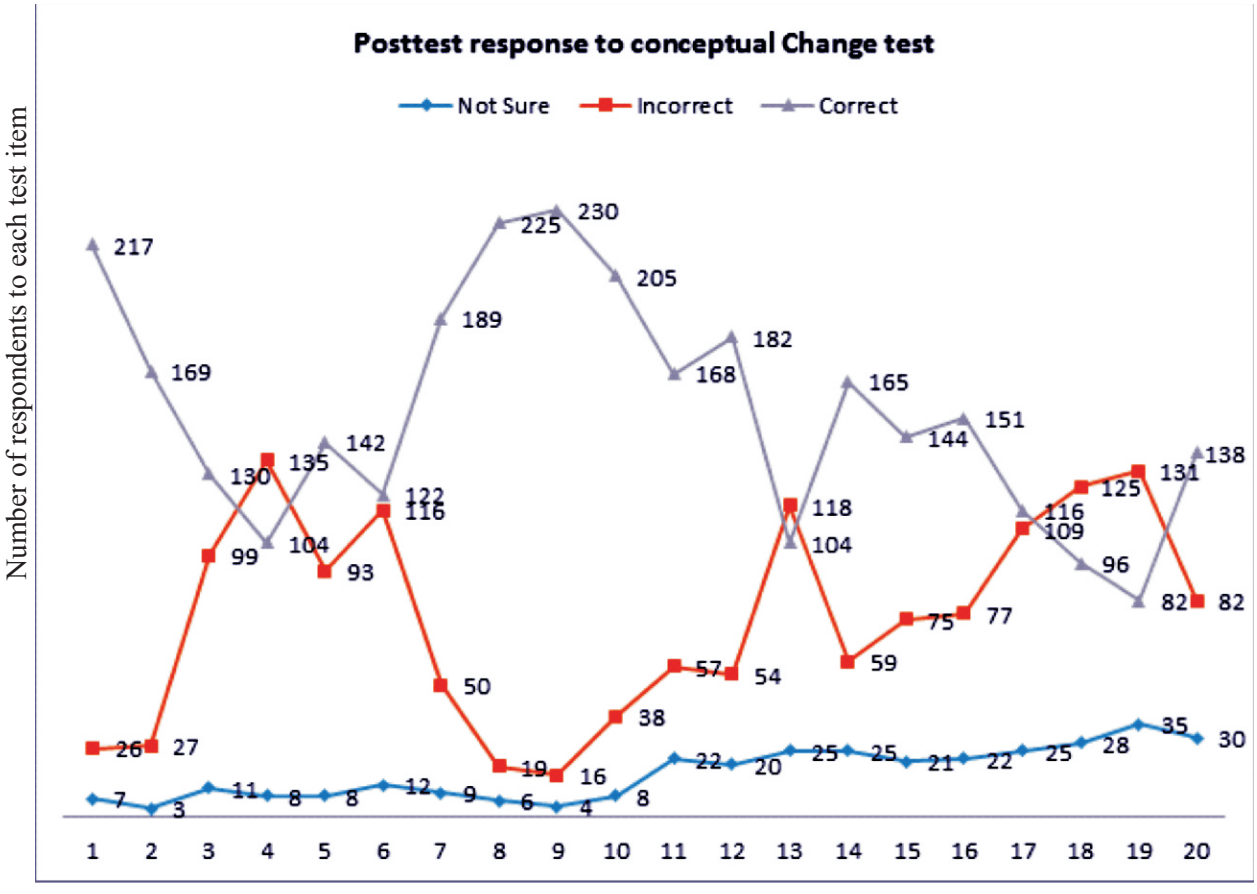


Figure I: Graph of pretest response to conceptual change



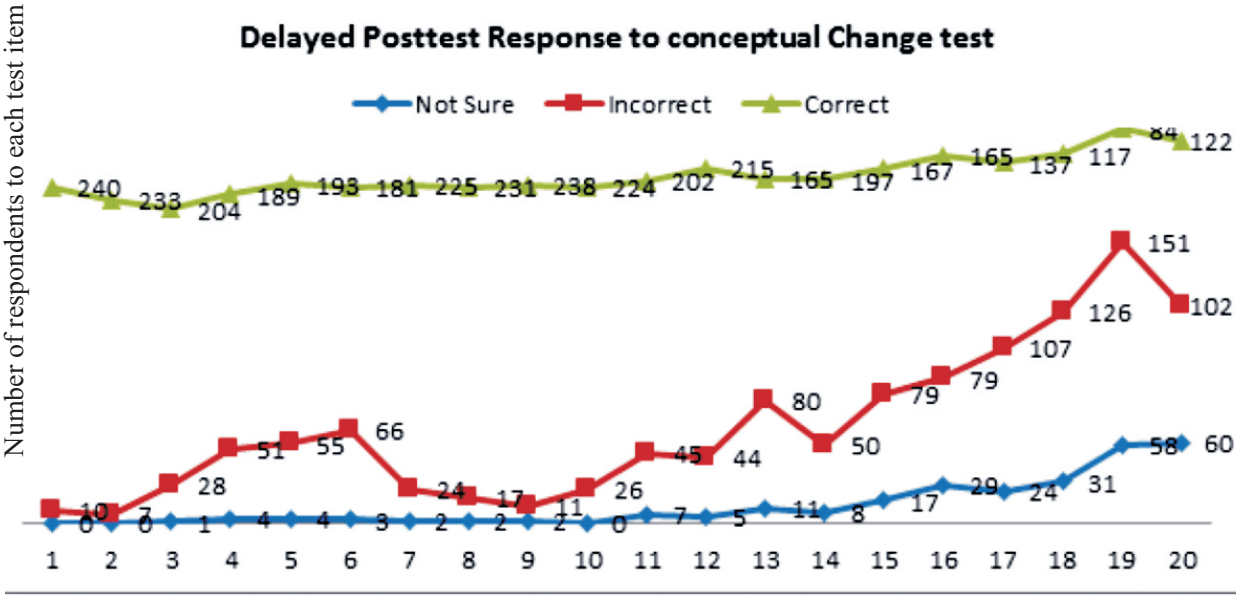


Figure III: Graph of Delayed Post-test Response to Conceptual Change Test

Testing of Null Hypotheses

H0$_1$: There is no significant main effect of treatment on students' conceptual change in Biology

Table 2: Summary of Analysis of Covariance (ANCOVA) of Post-Conceptual Change by Treatment and Prior knowledge

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	971.262[a]	17	57.133	14.962	0.000	0.513
Intercept	1799.054	1	1799.054	471.133	0.000	0.662
Pretest	384.408	1	384.408	100.668	0.000	0.295
Treatment	166.809	2	83.404	21.842	0.000*	0.153
Prior Knowledge	1.499	1	1.499	0.0392	0.532	0.002
Treatment x Prior Knowledge	0.130	2	0.065	0.0170	0.983	0.000
Error	920.275	241	3.819			
Total	59151.000	259				
Corrected Total	1891.537	258				

. ^{2} = 0.513 (Adjusted R^2 = 0.479) * denotes significant at p≤0.05

Table 1.2 reveals that there is a significant main effect of treatment on students' conceptual change in biology ($F_{(2,241)}$ = 21.84; p<0.05, partial η^2 = 0.15). Thus, hypothesis 1 was rejected. In order to determine the magnitude of the significant main effect across treatment groups, the estimated marginal means of the treatment groups was carried out and the result is presented in Table 1.3.

Table I.3 Estimated Marginal Means for Post-Conceptual Change by Treatment and Control Group

Treatment	Mean	Std. Error
Explicit Reflective Strategy (ERS)	15.40	0.25
Conventional Strategy (CS)	12.79	0.42

Table 1.3 reveals that students exposed to Explicit Reflective Strategy (ERS) treatment group had higher adjusted conceptual change mean score of 15.40 in biology than their counterparts in the control group who were exposed to the conventional Strategy (CS) with mean score of 12.79. This order can be represented as ERS > CS

$H0_2$: There is no significant main effect of students' prior knowledge on students' conceptual change in Biology.

ANCOVA analysis in Table 1.2 above showed that students' prior knowledge had a significant main effect on students' conceptual change in biology ($F_{(1,241)}$ = 0.039; p≤0.05; partial η^2 = 0.00). Therefore, the null hypothesis 2 was rejected. This indicates that prior knowledge had significant effect on students' conceptual change in Biology.

$H0_3$: There is no significant interaction effect of treatment and prior knowledge on students' conceptual change in Biology.

ANCOVA analysis in Table 1.2 above revealed there was a significant interaction effect of treatment and prior knowledge on students' conceptual change in biology ($F_{(2,241)}$ = 0.017: p≤0.05; partial η^2 = 0.00). Thus, the null hypothesis 3 was rejected. This means that treatment and prior knowledge had interaction effect on students' conceptual change in Biology.In order to determine the magnitude of the significant main effect across treatment groups, the estimated marginal means of the treatment groups was carried out and the result is presented in Table 1.5.

Table 1.5: Estimated Marginal Means for Post-Conceptual Change by Prior Knowledge

Prior knowledge	Mean	Std. Error
Invalid	17.57	0.48
Valid	19.70	0.85

Table 1.5 reveals that valid prior knowledge students had higher adjusted post-conceptual change mean score in biology (19.70) while their invalid counterparts had lower post-conceptual change mean score (17.57).

Discussion of Findings

Students' pattern of conceptual change in Biology

There is a positive progressive pattern of students' conceptual change from pre-test to post-test and to delayed post-test in the experimental group more than those in the control group. The significant main effect of treatment and interaction effect of treatment and prior knowledge on students' conceptual change pattern could be attributed to the fact that explicit-reflective instructional strategy had been verified as teaching and learning strategy which stimulates students to use experiences to discover learning themselves through reflection on prior knowledge. This is in line with the assertions of Ige and Kareem (2012) that students perform better in Biology when they are allowed to reflect on their prior knowledge before learning a new concept. In support of this finding, an

examination of the literature of Akerson, Abd-El-Khalick and Lederman (2000) and Babayemi (2014) revealed that an explicit reflective instructional strategy is relatively more effective in furthering science teachers' and students' understandings of nature of science. Thus, the pattern of students' conceptual change shifted from a poor understanding of biological concepts in the control group to good conceptual understanding in the explicit reflective group in the pre-test, post-test and delayed post-test respectively.

Conclusion

Findings revealed that explicit- of reflective instructional strategy is more effective in facilitating students' conceptual change in biology than the conventional strategy. Therefore, it can be concluded that when students are allowed to reflect on their existing prior knowledge of biological concepts before being taught new knowledge, there would be a better retention of new knowledge and conceptual understanding in biology. In conclusion, teachers of biology should endeavor to make classroom teaching and learning very effective and productive by using instructional strategies such as explicit reflective instructional strategies which could facilitate students' conceptual change in biology.

Recommendations

The following recommendations were made based on the findings obtained:

(1) The use of explicit reflective strategy is recommended for learning of Biology concepts by students at the secondary school level since it had been proved effective in assessing students' prior knowledge before instruction which could lead to deeper understanding of concepts and longer retention of knowledge for students' conceptual change in Biology.

(2) Biology teachers should expose students to reflective and practical activities such as explicit reflective strategy to increase the retention of knowledge of biological concepts.

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