



Differential Effect of Test Preparatory Aid on Essay Item-Based Achievement of Secondary School Students in Biology

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Abstract

This study examined the differential effect of test preparatory aid on essay item-based achievement of secondary school students in biology in Ogun State. A 2 x 2 pretest-posttest non-randomized control group quasi-experimental research design was adopted for the study. Two intact classes (n= 71) of SSII students selected from two selected schools constitute the sample. Teacher's instructional guide with test preparatory aid (TIGWTA) and teacher's instructional guide without test preparatory aid (TIGWOTA) were the two stimulus instruments, while essay achievement test in biology (EATB) ($r=0.79$) was the response instrument used in data collection. However, analysis of covariance (ANCOVA) was applied to test the hypotheses postulated. Results showed a significant main effect ($F_{(1,70)} = 30.746$; $p<0.05$) of treatment on essay item-based achievement of secondary school students in biology. The results also showed a no statistically significant main effect ($F_{(1,70)} = 0.289$; $p>0.05$) of gender on essay item-based achievement of secondary school students in biology. Similarly, there was no significant interaction effect ($F_{(1,70)} = 0.182$; $p> 0.05$) of treatment and gender on essay item-based achievement of secondary school students in biology. It is therefore concluded that test preparatory aid is effective in fostering students' academic achievement in biology. Teachers of biology should endeavour to adopt test preparatory aid as instructional strategy in fostering students' academic achievement in biology.

Keywords: Test preparatory aid, Essay item-based achievement, Differential effect, Gender

Introduction

Science has contributed immensely to the development of the modern world and has been recognized as the bedrock of modern day technological breakthrough. Nowadays, countries all over the world, especially the developing ones like Nigeria, are striving to develop technologically and scientifically. Ogunleye (2002) stated that science is a dynamic human activity concerned with understanding the workings of our world. Without the science, it would have been difficult for man to explore his environment.

Science comprises the basic subjects such as physics, chemistry, mathematics, agriculture and biology. Biology is important science subject that is a requirement for professional courses like medicine, agriculture and pharmacy. According to Ofoegbu (2003), biology is a core science subject taken in secondary schools by majority of the students. In contemporary Nigeria, greater emphasis is placed on science and technological development. As a result students are encouraged to take up science-related subjects one of which is biology. Agommuoh and Nzewi (2003) acknowledged that science are critical factors in the process of development and can provide the basis for Nigeria's social, economic and political well-being. Many have come to realise that science and technology can be applied to solve most problems facing the nation. Eno (2005) predicted that in the nearest future, only persons with the appropriate knowledge and skills in science and technology will be required in the job market.

The implication of this is that economic survival, relevance and social mobility will depend considerably on the level and appropriateness of the knowledge and skills an individual has acquired through science education. Biological science education is needed to dispel ignorance, poor cultural practices and beliefs in the society. Nigerians are still enslaved by diseases, poverty and ignorance and these calls for effective science education that is relevant to the improvement of the society (Ibe, 2006)

The importance of biology at the secondary school level cannot be overemphasized. Consequently, the Federal Government of Nigeria and stakeholders in education have focused attention on how to improve the teaching and learning of biology (FRN, 2004). To this effect, some state governments have established special science secondary schools while the Science Teachers' Association of Nigeria and other relevant agencies have mounted long vacation programmes, conferences, workshops, seminars, science fairs and quizzes to improve the teaching and learning of science. In spite of these, students' achievement in biology has remained low (Okoye 2003, Ibe 2006). For instance, the achievement of students in biology at the end of the secondary school is still far from the expected height as shown in Table 1.

Table 1: Summary of WASSCE Results in Biology (May/June 2010 – 2017)

Year	Number of Candidates that sat for the exam	Number Passed at Credit level (A1-C6)	Percentage Passed at Credit Level (%)	Number Failed	Percentage Failed (%)
2010	1,300,418	645,633	33.90%	654,785	66.10%
2011	1,505,199	579,432	38.50%	925,767	61.50%
2012	1,646,150	587,044	38.82%	1,059,106	61.18%
2013	1,757,726	709,471	40.28%	1,048,255	59.72%
2014	1,414,138	778,905	55.07%	602,421	44.93%
2015	1,181,567	628,684	53.20%	528,357	46.80%
2016	1,087,698	802,539	73.78%	261,164	26.22%
2017	1,093,597	263,134	65.79%	342,276	34.21%

Source: West African Examination Council (WAEC) National Office, Onipanu, Lagos

Table 1 shows that credit pass in biology between 2010 and 2014 was below 50% (2010-33.90%, 2011-38.50%, 2012-38.82% and 2013-40.28%). There was a marginal improvement in the results between 2015 (55.07%) and 2016 (53.20%). Looking further at the table, a remarkable improvement in the results was recorded for 2016 (73.78%) and 2017 (65.79%). Though the results for the period between 2010 and 2014 reflected a steady increase in academic achievement in biology, there is still room for improvement.

Poor achievement of students in biology can be attributed to factors such as: unavailability of laboratory facilities, lack of instructional materials, inadequate time allocation, large class size and poor instructional delivery approaches. According to Etukudo (2009), the fall in achievement in biology is attributed to poor instructional delivery approach adopted by teachers in schools. Shaibu (2014) noted that students' achievement in biology observed over a seven-year period is worsening compared to performance of other science subjects. This calls for concern as credit pass in biology is a prerequisite for courses in pharmacy, biochemistry, nursing, medicine and other allied disciplines.

Salau (2009) traced the poor achievement in public examinations to numerous factors such as instructional delivery approaches, inappropriate learning aid adopted by teachers, students' poor understanding of the rubrics attached to exam papers, poor usage of rubrics as an assessment mechanism of test items by teachers in internal examinations. This implies that the mastery of biology concepts might not be achieved without the use of effective instructional delivery approaches, proper students' understanding of instructions attached to exam questions and proper usage of test preparatory aids by teachers as assessment guides to students.

The term "test preparatory aids" refer to teachers' essay test aids designed to guide students' proper understanding of essay test instructions and test items (Popham, 2007). Essay tests are usually employed in high school biology classes, to foster students' understanding and performance in both classroom based essay test and external examinations (Andrade, 2005). Test preparatory aids according to Williams (2010), could be referred to as instructional aids often used by teachers to provide remediation to students with weak performance in essay tests. The preparatory aids comprise of general essay test instructions and interpretation, as well as specific essay language often used to prepare essay questions and the corresponding responses expected to be provided by students when answering essay test questions.

Andrade (2005) affirms that if carefully administered to students, test preparatory aids can improve student's understanding of the goals of an assignment and support teachers in unbiased grading, giving feedback and assigning more challenging work to students. Schafer, Swanson, Bené and Newberry (2011) investigated the effects of pre-essay test aids on students' achievement in Mathematics and found that students who were exposed to test preparatory aid performed significantly higher than students

who were not given the same treatment. The importance of test preparatory aid to students' academic achievement in essay tests is evident in the work of Andrade, Du and Wang (2008) who tested the effects of test preparatory aid on students' understanding and interpretation of essay items in chemistry. The study found that the quality of students' writing was positively related to their exposure to test preparatory aid. The researchers further recommended that teachers should adopt test preparatory aid to students when answering essay items.

The West African Examination Council (WAEC) Chief Examiner's Report (2010-2015) states that the persistent poor achievement of students in biology leaves one in doubt about the effectiveness of instructional delivery approaches and teaching aids popularly used by biology teachers for classroom instruction. The WAEC chief examiner recommended appropriate usage of test preparatory aids to assist students in understanding test items. This will improve students' problem solving skills in biology.

Many studies (Jocelyn, 2010, John 2009, Wilcock, 2009, Priya, 2012) have examined the effects of instructional approaches on students' academic achievement in biology and reported that the use of instructional aids significantly affects students' achievement. However, no research has been conducted in Nigeria on students' understanding of essay test instructions and items and their effects on academic achievements in biology. This study sought to determine the differential effect of test preparatory aid on essay item-based achievement of students in secondary school biology. The study specifically investigated the relative effect of test preparatory aid and gender as well as the interaction effect of the two variables on students' academic achievement in biology using essay test items.

Statement of the Problem

The persistent poor achievement of students in biology at senior school certificate examination have been attributed to numerous factors such as poor instructional delivery, school factors, teacher factors and a poor understanding of essay test instructions and items. Of all these factors, this dearth of studies on poor understanding of biology essay test instructions and items. This study sought to determine the differential effect of test preparatory aid on essay item-based achievement of secondary school students in biology.

Hypotheses

The following hypotheses were postulated for the study:

- H₀₁: There is no significant main effect of treatment on essay item-based achievement of students in secondary school biology.
- H₀₂: There is no significant main effect of gender on essay item-based achievement of students in secondary school biology.
- H₀₃: There is no significant interaction effect of treatment and gender on essay item-based achievement of students in secondary school biology.

Research Design

This study employs the use of 2 X 2 pre-test-post-test non-randomized control group quasi experimental design. This design is appropriate because participants were not randomly assigned to treatment conditions; rather it was the treatment that was randomly assigned to groups.

Experimental group	=	O_1	X_1	O_2
Control Group	=	O_3		O_4

Where:

O_1, O_3 = Pre-test
 O_2, O_4 = Posttest
 X_1 = Treatment

Sample and Sampling Techniques

The population for this study comprises all Senior Secondary Two (SS2) students offering biology in all public schools in Ogun East Senatorial District of Ogun State. Two senior secondary schools across Ijebu –Ode and Odogbolu Local Government Areas were randomly selected for this study. From each school, an intact class of SS2 students offering biology was chosen and later assigned randomly to either of the two treatment groups.

Instrumentation

The three instruments are:

1. Essay Achievement Test in Biology (EATB)
2. Teacher's Instructional Guide with Test Preparatory Aid (TIGWTA)
3. Teacher's Instructional Guide without Test Preparatory Aid (TIGWOTA)

EATB is the response instrument for this study. EATB was a self-developed instrument by the researchers to measure students' achievement in biology. EATB is an extended-response essay type of test containing instructions and two sections. Four essay items were drawn from three topical areas of SS2 curriculum in biology. The topics were joints and digestive system in animals and tissues and supporting system in animals.

TIGWTA is a stimulus instrument self –developed by the researcher to offer planned instruction on selected topical areas to the students. In addition to the usual outline of steps involved in instructional delivery, TIGWTA contains a list of words commonly used by examiners in the preparation of test items. The instrument also directs the attention of the students to how indispensable test instructions are and the correct interpretations expected of them.

TIGWOTA is an alternative to TIGWTA. It shares the same features with TIGWTA except that it is without the component that gives attention to test preparatory aid. To achieve content validity of the instruments, the researchers contacted senior secondary school teachers in biology and experts in educational evaluation who reviewed the content, language and format of the items. EATB was trial tested on thirty (30) S.S.2 students' selected from a location that is not part of the main study. However, inter-rater reliability was done and 0.79 coefficient was obtained. Test of reliability for TIGWOTA and TIGWTA was however qualitative.

Data Collection Procedure

Informed consent of the selected participants was sought and obtained. The procedure that was adopted for data collection involves pre-test, treatment, and post-test.

Administration of Pre-test

Pre-test is the initial stage where EATB was administered to both the experimental group and the control group before the administration of treatment. The pre-test stage involves;

- a. Choosing an intact of SS2 biology students in the two randomly selected senior secondary schools for this study.
 - b. The researchers then exposed the two groups (experimental and control) of students to the prepared essay test (EATB).
 - c. The researchers then collated the scripts of the students after the test.
- However, the pre-test was conducted on the first day of the exercise.

Treatment

The treatment was administered in four (4) weeks starting from the second day of administering pretest. Students in the experimental group were exposed to the treatment with teacher's instructional guide with test preparatory aid (TIGWTA), while students' in the control group were taught using teacher's instructional guide without test preparatory aid (TIGWOTA).

Administration of Post-test

After the treatment, EATB was administered as posttest to the two groups in order to measure the effect of the treatment without compromising the different backgrounds of instructions and items in biology. The post test was conducted on the last day of the exercise. The data obtained formed the basis of data analysis. The hypotheses were tested using analysis of covariance (ANCOVA) at 0.05 alpha level of significance.

Results

H₀: There is no significant main effect of treatment on students' interpretation of instructions and question items in secondary school essay test in biology.

Table 2: Test of Between Subjects Effects

Source	Types II Sum of Squares	df	Mean Squares	F	Significant
Corrected Model	3237.240 ^a	4	809.310	9.932	0.000
Intercept	3155.342	1	3155.342	38.723	0.000
Pretest	321.537	1	321.537	3.946	0.051
Treatment	2505.302	1	2505.302	30.746	0.000
Gender	23.557	1	23.557	0.289	0.593
Treatment * Gender	14.800	1	14.800	0.182	0.671
Error	5377.943	66	81.484		
Total	36142.000	71			
Corrected Total	8615.183	70			

a. $R^2 = 376$ ($R^2_{adj} = .338$)

The results of analysis of covariance (ANCOVA) ($F_{(1,70)} = 30.746$, $p < (0.05)$) presented in Table 2 indicates that there exists a significant main effect of treatment (Test preparatory aid) on essay item-based achievement of students in secondary school biology. In other words, test preparatory aid determines students' achievement in biology with respect to essay test items. Thus, the null hypothesis which states that there is no significant main effect of treatment on essay item-based achievement of students in secondary school biology is rejected and the alternative hypothesis is accepted. The model costing of treatment (test preparatory aid) gender and pretest combined makes a contribution of 37.6% to variance in secondary school students' achievement in biology with respect to essay test items. The contribution is significant at $F_{(4, 66)} = 9.932$, $p < (0.05)$.

Table 3: Estimated Marginal Means

Treatment	Gender	Mean	Std.Error	95% Confidence interval	
				Lower Bound	Upper Bound
Experimental	Male	23.746 ^a	2.020	19.713	27.778
	Female	24.028 ^a	1.677	20.679	27.377
Control	Male	9.432 ^a	2.434	4.572	14.292
	Female	11.778 ^a	3.239	5.312	18.245

a. Covariates appearing in the model are evaluated at the following values: pretest=4.01

Looking at estimated marginal means involving interaction of treatment and gender in Table 2, the margin of gain in achievement between test preparatory aid and control groups ($\text{Mean}_{\text{experimental}} = 23.746 > \text{Mean}_{\text{control}} = 9.432$; $\text{Mean}_{\text{experimental}} = 24.028 > \text{Mean}_{\text{control}} = 11.778$) was high. From the results in the Table, mean scores for both male and female students were closer together for the experimental group than the control group.

Ho₂: There is no significant main effect of gender on essay item-based achievement of students in secondary school Biology.

Given the results of ANCOVA ($F_{(1,70)} = 0.289, p > (0.05)$ in Table 2, there is no significant main effect of gender on essay item-based achievement of students in secondary school biology. In other words, gender is not a determinant of secondary school students' achievement in biology in relation to essay test items. Thus, the null hypothesis which states that there is no significant main effect of gender on essay item-based achievement of students in secondary school biology is not rejected, rather the alternative hypothesis is rejected.

Ho₃: There is no significant interaction effect of treatment and gender on essay item-based achievement of students in secondary school biology.

Considering the results of ANCOVA ($F_{(1,70)} = 0.182, p > (0.05)$ in Table 2, it is obvious that interaction effect of treatment (test preparatory aid) and gender on essay item-based achievement of students in secondary school biology is not significant.

Discussion of Findings

The finding in relation to the speculation that there is no significant main effect of treatment indicates that there was a significant main effect of treatment on essay item-based achievement of students in secondary school biology. The finding is consistent with that of Skidmore and Aagaard (2004); Wachsmann (2002) who, in their respective studies, submitted that test preparatory aids help students to review, organize, and clarify the main points of material that will most likely appear on a test and foster their learning outcomes. Further supporting the empirical findings above, Loftman (2005), Zimmerman and Pons (2006) investigated the impact of exposing students to test preparatory aid prior to exams. Both groups of researchers found that test preparatory aid exposure increases students' overall engagement with course content, increase familiarity with materials (and thus potential exam questions), and increase study time. They found that students who were exposed to test preparatory aid prior to exam significantly outperformed students who were not. Thus, assisting students with test preparatory aid produced tremendous beneficial effects on the students; hence, it could be inferred that effective student interpretation of test instructions and items in biology, particularly essay test, could be fostered through the adoption of test preparatory aid by teachers of biology as an instructional strategy.

The findings also show that, there is no significant main effect of gender on essay item-based achievement of students in secondary school biology. Similarly, interaction effect of treatment (test preparatory aid) and gender on essay item-based achievement of secondary school students in biology was not significant. This showed that treatment method is not gender biased and thus indicate that both male and female students' achievements in biology are not significantly different from each other. A few results of previous studies (Abu, 2000; Ibe, 2004; Ogu, 2010; Bichi, 2012; Odubunmi & Onafowokan, 2013) compare favourably with this finding. Abu (2000) reported that there was no significant difference in the performance of male and female students taught using individualized guided discovery method of teaching.

Ibe (2004) also reported that there was no significant difference in the achievement of male and female students in a study that determined the effect of guided inquiry and demonstration methods on science process skill acquisition among secondary school students of biology. In the same vein, Ogu (2010) observed a no significant difference between students' performance scores based on gender after being taught using the process skill-based science teaching method. Bichi (2012) investigated effects of problem solving strategy and enriching curriculum on senior secondary school students' achievement in evolution concepts. His results indicated there was no significant difference in students' achievement based on gender. In another study, Odubunmi and Onafowokan (2013) examined the effect of hands-on experience method of teaching basic science at junior secondary school level and the result showed there was no significant difference in performance based on gender.

In contrast, Okoro (2011) studied the effect of interaction patterns on achievement and interest in biology among secondary school students. Findings from the study indicated that male students' achievement and interest scores were significantly higher than that of their female counterparts exposed to three interaction patterns (cooperative, competitive and individualistic patterns of learning). In addition, Okwor (2007) found no significant interaction effect of gender and instructional treatment on students' achievement in chemistry. Gender was not supposed to be a factor of academic achievement since intelligence is not distributed along gender divide. Apart from the notable features of identification between male and female individuals for the purpose of procreation, both sexes appear to be the same a great deal. It is likely the factor of culture have mediated the effect of treatment across gender in Okoro (2011) unlike Okwor (2007). Interest of individuals is culturally ruled by gender to a far extent. There are some areas of interest that are peculiar to male gender and vice versa. Generally, gender stereotypes vary from culture to culture. However, cultural influence on gender is construct-specific. A good example of a construct where cultural influence is ruled out is academic achievement.

Conclusion and Recommendations

Based on the findings of this study, test preparatory aids have been found effective in fostering improved academic achievement in biology among students of secondary schools.

Based on the findings, the following recommendations are proffered:

1. Teachers should endeavour to adopt test preparatory aid in fostering students' academic achievement in biology.
2. Regular in-service training should be organized by the government for teachers, on techniques of modern teaching strategies such as test preparatory aid, so as to foster increased students' academic achievement.
3. Government should upgrade measures aimed at recruiting competent teachers of biology alongside others who are pedagogically equipped in classroom instruction. This will foster improved learning among the students.

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