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ABSTRACT

The purpose of this study was to analyze the errors made by high school students in practical biology and the extent to which boys and girls differ in terms of the frequency of errors committed. The subjects included 317 students from the twelfth grade sampled from five different schools in Nigeria. A criterion level of 0.05 was set to test the two null hypotheses: there is no significant difference in error types between schools and there is no significant difference in the frequency of error types committed by boys and girls in practical biology examinations. One-way analysis of variance and chi-square statistics were used to test these hypotheses. The results of the analysis showed that all the subjects committed certain degrees of errors which differ from school to school. These errors were found to be gender-related with girls committing less errors than boys. It is suggested that teachers should spend more time exposing students to possible errors during practical lessons in order to reduce the errors committed and thus improve the students' achievements. Contains 28 references. (Author/JRH)

Abstract

GENDER-RELATED DIFFERENCES IN ERROR ANALYSIS OF SOME NIGERIAN HIGH SCHOOL STUDENTS IN PRACTICAL BIOLOGY

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The purpose of this study was to analyse the errors made by high school students in practical biology and the extent to which boys and girls differ in terms of the frequency of errors committed. For this purpose, 317 students, from the twelfth grade (senior secondary three), sampled from five different schools were used for the study. A criterion level of 0.05 was set to test the two null hypothesis, namely - there is no significant difference in error types between schools, and there is no significant difference in the frequency of error types committed by boys and girls in practical biology examinations. To test these hypothesis the one-way analysis of variance and the chi-square statistics were used respectively. The results of the analyses showed that all the subjects committed certain degrees of errors which differ from school to school. These errors are gender-related with the girls committing less errors than the boys. Possible explanation to the above findings and suggestions are discussed.

INTRODUCTION:-

The low participation of girls in high school courses of science and technology has been well documented and been the subject of world-wide - concern since the 1970's (Shemesh 1990; Murphy 1987; Lockheed et al 1985; NAEP report 1983). In fact the change of status of science from an optional to a compulsory subject in most countries is all in an attempt to alter the situation. But according to Shemesh (1990) girls who still choose to study science prefer subjects that are different from boys-for boys are more oriented toward the so-called "hard sciences (physics, chemistry etc.), and girls prefer the "soft" subjects such as human physiology. plant life, zoology etc. (Entwistle and Duckworth 1977; Jungwirth 1973 and Tamir 1975).

There has also been an increased emphasis on practicals or active learning with the recent curriculum innovations in science. In fact a number of science educators have enumerated the need for practical work in science (e.g. Head 1966, Ndu 1980, Bently and Watts 1985) and the practical nature of a subject is commonly regarded as an important source of pupil motivation (Bryce and robertson 1985).. However other critics view it as having little value to learning, too expensive in terms of space and equipment, too dangerous for pupils in Junior High School and time consuming (Hempstead 1973).

As regards gender differences and practicals, there had been contradicting messages coming from literature about girls and boys attitude and performance on practical activities (e.g. Harding et al 1988, Omerod 1981, Kelly 1981). For instance Omerod (1981) found practical work an added incentive for boys to study the three science subjects but not for girls, while Huilderbrand (1989) found practical work a way of combating sex differences. Some National science surveys have shown large differences in favour of boys on practical test (Kelly 1981) and still other studies either showed no difference or a trend in favour of girls (Department of Education and Science 1988). Girls lack of confidence in practical contexts and fear of practical equipment has also been noted (Murphy 1987).

In Nigeria, biology is one of the science subjects many students like to take at both the secondary and tertiary level since it is a requirement for most science disciplines in the universities. Students are expected at the end of the senior high school to sit for an examination (called senior secondary certificate Examination SSCE) made up of theory, multiple choice and practicals. Despite the high enrolment in this subject which confirms its relative popularity among other science subjects (Olaniyi, 1995; Turton 1991), the students' performance in this subject at the SSCE is depressingly poor (Turton 1991).

The low percentage passes in biology has been attributed to the errors students commit in practical biology among other factors (Aramide 1985, Kumari and Aliyu 1985).

The objective of this study, therefore, is to analyse errors made by students in practical biology and the extent to which boys and girls differ in terms of the frequency of error type.

A criterion level of 0.05 was set to test the two null hypotheses, namely:

1. There is no significant difference in error types between schools.
2. There is no significant difference in the frequency of error types committed by boys and girls in practical Biology examination.

Sample and Procedure

The sample consisted of 317 final year high school biology students from five (5). Schools. This consisted about 50% of the total enrolment in biology in different schools North of Nigeria. The sample school consisted of one co-educational, two boys and two girls schools with a mean age of 16 years. The students responded to the instrument during one of their biology practical periods. At the end of the tests. the answers scripts were vetted by biology teachers who had experience in marking WAEC examinations.

The five schools selected were judged to be particularly suited for this study since they had graduated and presented students for the Senior Secondary Certificate Examination (SSCE) for minimum of five years running.

Instrument

There are two instruments used for data collection and analysis.

1) The West African Examination Council (WAEC) question and marking scheme:

The West African Examination Council is the body responsible for the drawing of examination syllabuses for the Senior Secondary Certificate Examination (SSCE) as well as conducts the examination leading to the award of this certificate.

For data gathering purpose, practical biology examination test questions of WAEC (1988-1992) for SSCE questions were randomly sampled. The test consisted of two sections; Section A is made up of short answer questions, and Section B is made up of long answer questions requiring the use of certain instruments, drawing, identification of specimens, etc. A total of ten short answer questions were randomly selected for Section A out of a total of 49. For Section B, three long answer questions were randomly selected out of 15. These 10 short answer questions and 3 long answer questions and marking schemes were selected in line with the number of questions set by WAEC every year. These questions and marking schemes were however not validated since the WAEC questions and marking schemes are assumed valided being the only central and recognised examination body in West Africa.

Below are an example of questions and marking schemes in section A and B.

Section A (Short Question)

i) What would you observe if a filament of spirogyra is immersed in 0.1 molar sodium chloride-solution for about one hour.

ii) Name the process which occurs during the immersion of the spirogyra filament in the 0.1 molar sodium chloride solution.

Marking Scheme (2 marks)

i) Shrinkage of the cell/shrink. (1 mark)

ii) Plasmolysis (1 mark)

a) Section B (Long Questions)

i) Identify specimen A, B, C, without reasons.

ii) Cut a transverse section through specimen A and make a labelled drawing 6-8cm wide to illustrate the essential features of the cut surface only.

iii) What type of fruit is it? Give two reasons for your answer.

b. i) State two features each which contribute to the dispersal of the seeds of specimens A and B.

ii) Name one agent of dispersal for each of specimens A and B.

c. Cut a stransverse section through specimen C. State two similaries and two differences in structure in tabular form between specimens A and C.

Marking Scheme

a. i) Specimen A is mango/oil palm/coconut fruit.

Specimen B is tridax/Emilia

Specimen C is tomatoe/guava (3 marks.)

ii) Drawing of specimen A:

Quality of drawing:

M - Magnification (x1/2 - x1) (1 mark)

S - Size (6 - 8cm) (1 mark)

C - Clarity of lines (1/2 allowed) (1 mark)

Details:

DL - Double lines fo· cut surface

Ed - Hard endocarp shown

Ms - Soft mesocarp shown (3 marks)

Labels:

Epicarp. mesocarp. endocarp. seed. (2 marks)

iii. Drupe:

- Hard endocarp

- One seed (3 marks)

b) i. Specimen A - hard endocarp

- succulent mesocarp

- brigh: colour

(Any 2 x 1 mark = 2 marks)

Specimen B - hairy parachute

- light (easily carried by wind)

(2 marks)

ii. Specimen A - man

Specimen B - wind (2 marks)

c) Similarities:

Mango (A)	Tomatoe/Guava (C)
- Seed present	- Seed present
- Contain 3 layers epicarp, mesocarp and endocarp	- Same
- Succulent mesocarp	- Same

(Any 2 x 1 mark = 2 marks)

Differences:

Mango (A)	Tomatoe/Guava (C)
- One seed	- Many seed
- Hard endorcarp	- Soft endocarp
- Placentation marginal	- Axial placentation

(Any 2 x 1 mark = 2 marks)

(TOTAL = 24 MARKS)

2. Error Types

A list of ten error types in the SSCE Biology Practicals (WAEC 1985/86 Regulations) were selectec in line with the questions set. Examples of such error types are as follows:

i) Drawing errors, ability to represent observations, diagramatically and accurately. Drawings should be with HB pencil, magnification indicated, proper title, drawing line not woolly, wavy or doted. Spelling of parts labelled must be correct. Label line drawn with ruler and must be horizontal, no shading of parts. Cut surfaces represented by double lines. Any digression from any of the above. error is committed.

ii) Spelling of technical terms must be correct, for example in writing Hepatic portal vein, any mistake in the spelling above an error is committed, e.g. Hepartic Portal vein.

iii) Inability to follow instruction accurately. If a student is required to cut and draw a cross-section of a specimen. if instead the student cuts a longitudinal section and draws that, he also has committed an errors, cutting and drawing wrong view.

Reliability of the Test - Items

The questions set were administered to a sample of students similar to the sample to be used and a test-retest conducted. The reliability coefficient of the test-retest was calculated to be $r = 0.97$ at 0.05 level of significance using Pearson product moment co-efficient of correlation.

For the errors made, each of the scripts was taken and each question analysed to see why the subject failed in cases were they obtained no score. The error made is thus recorded for each question. Failure by a subject to obtain a score for a particular number is marked as wrong with a tallying mark against the criterion concern. the total number of errors in each of the 10 criteria or error types was then added up to give the total errors for each student.

RESULTS

Table I below shows the mean scores and standard deviations of each of the error types by schools.

Table I - MEAN SCORES AND STANDARD DEVIATION OF ERROR TYPES BY SCHOOL

SCHOOL	ERROR TYPES									
	I	II	III	IV	V	VI	VII	VIII	IX	
A {74}	10 19 (2 94)	3 97 (1 94)	0 04 (0 2)	0 86 (0 78)	6 78 (2 64)	3 62 (2 24)	2 82 (2 2)	6 12 (3 2)	0 72 (1 26)	1 39 (0 86)
B {48}	8 73 (2 66)	3 19 (1 45)	0.79 (0 41)	0 77 (0 78)	3 52 (1 82)	3 44 (1 50)	3 6 (1 99)	8 0 (4 05)	2 85 (1 05)	1 6 (1 45)
C {63}	9.05 (3 59)	2 30 (1 83)	0 37 (0 55)	0 90 (0 73)	3 3 (2 14)	4 33 (2 16)	3 92 (2 24)	9 95 (5 3)	2 33 (1 87)	2 02 (1 57)
D {71}	11 46 (2 48)	3.25 (1 36)	0 76 (0 43)	0.87 (0 88)	3 08 (1 67)	3 23 (1 19)	3 48 (1 54)	13 62 (4 99)	2 13 (1 72)	1.73 (1 32)
E {60}	10 10 (2 87)	2 45 (1 41)	0 03 (0 18)	0 35 (0 66)	1 47 (1 74)	2 42 (1 32)	3 33 (2 34)	10 55 (4 89)	1 15 (1 99)	1 87 (1 77)

*Figures in bracket ( ) are standard deviation and { } are number of subjects in each school

In order to test the first hypothesis that there is no significant difference in error types between schools, a one-way analysis of variance was used (of 5 schools and 10 error types). This statistics was used because all the five schools were drawn from the same parent population. The results obtained are as shown on Table 2 below:

TABLE 2: SUMMARY OF ONE-WAY ANOVA FOR Ho 1

Source of Variation	SS.	df.	Ms	F.
SSb	506.9	9	56.3	
SSw	59.5	40	1.48	*38.0
SSt	566.4	49		

*F calculated was found to be 38.0
F critical at $df_1 = 9$, $df_2 = 40$ is 2.86

From the results, the F calculated value is greater than F critical at 0.05 level of significant (Fcal > Fcri). Thus the relevant null hypothesis was rejected. It can therefore be conclused that there is a significant difference in error types between schools.

To test the second hypothesis that there is no significant difference in the frequency of error types committed by boys and girls in practical biology examination, the chi-square statistics was used since the result was in frequency counts.

The results obtained are indicated on Table 3 below:

Table 3: ERROR TYPES BY GENDER

GENDER	ERROR TYPES										
	I	II	III	IV	V	VI	VII	VIII	IX	X	TOTAL
Male	1711	457	79	132	488	590	595	1986	320	301	6659
	(1753)	(534)	(66)	(133 7)	(660 6)	602 7)	(597)	(1716 8)	(290 8)	(295.5)	
Female	1463	510	41	110	708	501	486	1122	221	234	5396
	(1420.7)	(432.8)	(53.7)	(108)	(535	(488)	(483 9)	(1391)	(242)	(239 5)	
TOTAL	3174	967	120	242	1196	1091	1081	3108	541	535	12055

Figures in bracket ( ) are expected cell frequencies

X^2 value obtained by calculation = 233.5. With df 9 (P = 0.001) X^2 critical from table was found to be 27.88.

From the results critical value for X^2 is less than the calculated value. The null hypothesis of no significant difference in frequency of errors committed by male and female subjects was rejected.

Ability of a subject to commit error therefore appears to be sex-related; with the females committing less errors than their male counterparts in most of the error types.

Discussion

The results of the analyses above showed that all the subjects committed certain degree of error in each of the ten groups of error types, although the degree differ from school to school. This is clearly indicated on Table I where the mean scores for each of the error types is indicated by school. The result of the one-way analysis of variance showed a significant difference in error types between schools which might be due to the fact that the students were not adequately taught. This confirms earlier conclusions made by Osenuga (1981). Abijo (1982); Aramide (1985) and Soyinbo (1992).

The results on Table 3 also suggested that errors committed by subjects was gender related with the females committing less errors than their male counterparts and subsequently achieving more. This supports Entwistle and Duckworth (1977), Jungwirth (1973); and Tamir (1975) studies that girls actually prefer the soft subjects such as Biology, Zoology, etc. and boys the hard sciences.

Although this findings agree with Ameh (1980) study that girls are usually more careful in practicals because of their cultural background, Kelly (1981) however found a large differences in favour of boys on practical test. Since girls and boys do appear to experience practical work differently, classroom strategies will have to take account of boys and girls present preferred styles of working and interest as well as providing opportunities for them to reflect critically on them (Ogunsola-Bandele 1987, 1993)

In order to reduce the errors committed and thus improve the students achievements, the teachers should spend more time exposing students to possible errors during practical lessons. Also biology teachers should teach the subject as both content and process rather than the present "chalk and talk" method operating in most schools.

Finally inclusion of practical work directed towards a single outcome should also be resisted. Pupils should not be encouraged to find out what the teacher wants alone but other expected and possible outcomes. For according to Roger (1987), increased opportunity should be provided for practical work of a genuinely open-ended nature.

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