EMPIRICAL ANALYSIS OF ITEM DIFFICULTY AND DISCRIMINATION INDICES OF SENIOR SCHOOL CERTIFICATE MULTIPLE CHOICE BIOLOGY TESTS IN NIGERIA

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Abstract

This study aimed at obtaining empirical data on the item difficulty and discrimination indices of senior school certificate examination (SSCE) multiple choice biology tests used by the West African Examinations Council (WAEC) and National Examinations Council (NECO) in Nigeria. Sample for the study consisted of 1450 Senior Secondary Three (SSIII) students, made up of 758 male and 692 female, drawn from 20 randomly selected secondary schools in Ekiti State, Nigeria. The instruments used for the study were 2008 NECO and WAEC multiple choice Biology test papers. Data analysis was done by the researcher using item by item analysis for obtaining the difficulty and discrimination indices. Findings from the study showed that 2008 SSCE Biology multiple choice test had mean difficulty index of 0.42 and this is slightly higher than NECO Biology multiple choice test with mean difficulty index of 0.40 and 2008 SSCE in Biology had a discriminating power of 0.43 and this is higher than NECO with mean discriminating power of 0.39. It was therefore recommended that; 4 option items especially in multiple choice Biology tests should be encouraged but if 5 options items should be used more attention should be given to psychometric properties of tests. Also, Governments should periodically organize in-service training programme for teachers on regular basis to broaden their knowledge in test construction, test administration and interpretation in order to improve students' performance in Biology in external and internal examinations.

Key words: *Difficulty Indices, Discrimination Indices, Multiple Choice Biology Tests.*

Introduction

Evaluation plays an important role in the educational process and development. It is crucial for teachers to make use of best evaluation practices in order to help the students to have better results in internal and external examinations. Evaluation can be described as systematic processes of determining the extent to which instructional objectives are achieved by students (Gronlund, 1981). Therefore, students' achievement can be used to determine to a large extent the degree of success or failure of an educational practice. Teachers' carry out a routine evaluation of school learning to achieve various objectives, but this is essentially internal.

These internal evaluations go by such names as teacher made tests, Continuous Assessment, School Based Assessment and local tests. For the conduct of external examinations however, there are recognized bodies that carry this assignment out for the whole country (Nigeria) and award certificates to candidates at different levels. The National Examinations Council (NECO) and the West African Examinations Council (WAEC) and National Business and Technical Examination Board (NABTEB) are the bodies authorized by the Nigerian law to conduct the Senior School Certificate Examinations (SSCE), General Certificate Examinations (GCE) and other exams. NECO, NABTEB and WAEC carry out summative evaluation of the Criterion Referenced Tests. Summative Evaluation is the type of evaluation, which typically comes at the end of a course of instruction. It is used primarily for assigning course grades of the intended learning outcomes. The purpose of summative evaluation is to assess the overall effectiveness of a programme (Susan, 2003; Nuhfer, 1996).

Another form of evaluation according to Tessmer (1993) and Scriven (1991) is the formative type. This refers to a form of structured testing procedure that is executed while teaching and learning are on-going with a view to bring about improvements (Nuhfer, 1996 and Susan, 2003). Tests used in formative evaluation are mostly teacher made tests and thus internal to the school system (Alonge, 2003). The school system adopts some other forms of evaluation in a

complementary manner with formative and summative evaluation such as placement, diagnostic evaluation and so on.

The common form of test used for both formative, summative evaluation and other forms of evaluation by teachers for internally conducted assessments and statutory examining bodies for external assessment are of the objective, essay and practical variants. Objective tests are not only popular in internal and external examinations; they also play a crucial role in assessment processes in the school system. The multiple choice test type of objective test is regarded as the most applicable, flexible and useful type of objective test items. Multiple choice tests are widely acclaimed as most reliable because of consistency in scoring the test as well as its fairness to all students (Osunde, 2009). Multiple choice tests discourage the learner's tendency to anticipate likely questions but encourage them to cover the whole contents taught in their preparations. They are also useful in assessing learners' mastery of specific facts, concepts, terms, laws and principles (Lawal, 2001 & Kolawole, 2005).

According to Kolawole (2005), multiple choice tests require students to select the answer from a number of possible alternatives. Multiple choice items give the fairest opportunity to testees to prove their competence and testers to prove their integrity. Its objectivity is both in terms of development and scoring as items cover wider curriculum contents and objectives of instruction. It is adjudged as having good validity since it has the tendency to cover all aspects of learning content (Alonge, 2003 & Lawal, 2001).

The usefulness of multiple choice tests (MCT) for achieving objectives of testing depends on its quality and properties. The importance of difficulty indices and discrimination power in multiple choice items cannot be overemphasized. According to Schumacker (2005), Classical Test Theory (CTT) utilizes traditional item and sample dependent statistics i.e. item difficulty and item discrimination. In classical theory the two statistics that form the cornerstone are item difficulty and item discrimination.

Adewuyi and Oluotun (2001) described Difficulty index of an item as the extent to which an item has been answered correctly by the testees. That is, the percentages of the testees that select the right option (Alonge, 2003). Going by this definition of item difficulty, the closer to one (1) the value of the difficulty index is, the simpler the item and the closer the value to zero, the more difficult the item is.

Difficulty index actually tells us how easy the item was for the students in that particular group. The higher the difficulty index the easier the question and the lower the difficulty index the more difficult the question. The difficulty index, in fact equals to "Easiness index" (Zafar, 2008). Abiri (2006) also indicated that multiple choice tests with fewer numbers of options have better difficulty indices than those with larger number of options.

Discrimination power of multiple choice items on the other hand is the ability to discriminate between the brilliant students and poor students (Alonge, 2003). On the other hand Oyejide, (1991) described discrimination power as the strength of each item to distinguish the higher achievers (those who are more competent) from the lower achievers (those who are less competent). Discrimination power of a test ranges from zero to one (0-1). The closer this value is to one (1) the better the item is (Oyedeji, 1991 & Kelly, 1989). The index of discrimination is also the extent to which a test is correctly responded to by those examinees possessing more of the traits being measured (Ebel, 1979 & Alonge, 2003).

The role of assessment or test is very vital in evaluating students in the school setting. West African Examinations Council (WAEC) and National Examinations Council (NECO) organize the Senior Secondary Certificate Examination (SSCE) in Nigeria and they are essentially used for certification. In Nigeria, MCT is being used by examining bodies like National Examinations Council (NECO) and West African Examinations Council (WAEC) and other public examination bodies.

National Examinations Council (NECO) was created by a decree in April, 1999. It has its headquarters in Minna, Niger State. NECO took off on 26th April, 1999. The National Examinations Council established in April, 1999 has the sole responsibility of conducting the Senior School Certificate Examination (SSCE), hither-to being conducted by West African Examinations Council (WAEC) (WAEC, 2007). The National Examination Council (NECO) conducted its maiden June/July SSCE in the year 2000 and has since continued to conduct Senior School Certificate Examination (SSCE) twice in a year (June/July and November/December) alongside with the West African Examinations Council (NECO, 2007).

West African Examinations Council as one of the examining bodies in Nigeria was established in 1952 following the acceptance of the Jeffery's Report by the then colonial Governments established by five West African Governments namely Ghana, Liberia, Gambia, Nigeria and Sierra Leone who passed appropriate ordinances in their Legislative Assemblies in 1951 in collaboration with and in succession to, the Cambridge School Certificate Syndicate. It has his headquarters in Accra, Ghana while the Nigeria headquarters is in Yaba, Lagos (WAEC, 2007). It has the sole responsibility of organizing and conducting secondary schools and public examinations in West African countries such as the Gambia, Ghana, Liberia, Nigeria and Sierra Leone.

One of the emphases of the Nigerian educational policy is that citizens must acquire scientific and technological education. Biology is one of the science subjects and has links with other science subjects. It is the general field of knowledge concerned with the study of all aspects of living organisms. According to Parker (1992), Biology embraces those principles of widest application to the origin, growth and development, structure, function, evolution and distribution of plants and animals. It is also the bedrock upon which some science subjects derive their being (origin). Biology as the science of life enables the individuals to understand themselves, the parts and functions of their bodies. Biology has been subdivided into separate branches such as Botany,

Zoology, Physiology, Genetics, Morphology, Anatomy, and Biochemistry and so on. It is the fact that no student intending to study these disciplines can do without Biology.

The students' poor performance in Biology has drawn attention of researchers and curriculum planners towards Biology as a subject in the school curriculum (Kareem, 2003). In spite of the importance and popularity of Biology among Nigerian students, performance at senior secondary school level had been poor (Ahmed, 2008). The desire to know the causes of the poor performance in Biology has been the focus of researchers for some time now. The Chief Examiners' reports indicate that students have similar weaknesses in Biology papers which lead to students' poor performance in West African Senior School Certificate Examination (WASSCE) in Biology papers.

WASSCE Chief Examiners' Report May/June (2004) shows that the students' performance in Biology paper 1 was slightly poorer than the previous year with a mean score of 20 and a standard deviation of 9.60. In Biology paper 1 and the mean score for the paper 2 was 20 while the standard deviation was 7.48. WASSCE Chief Examiners' Report Nov/Dec. (2004) shows that the mean for Biology paper 2 (Essay) was 22 while the standard deviation was 8.94. Students' performance in this paper was fair compared with previous years. But, the performance of the candidates was poorer than the previous year in paper 3 (alternative to practical).

WASSCE Chief Examiners' Report Nov/Dec (2007) indicates that the performance of the students in paper 2 (Essay) was slightly poorer than that of the previous year with a mean score of 17 and a standard deviation of 8.77 compared to a mean of 18 and S.D of 8.94 for Nov/Dec 2006. In addition, students' performance in paper 3 (alternative to practical) was slightly poorer in 2007 with a mean score of 24 and a standard deviation of 12.17 compared with a mean of 28 and standard deviation of 7.64 for Nov/Dec 2006 WASSCE). Researchers shifted the blame of students' poor performance in Biology on teacher laxity, students poor study habits, parents poor attitude to their children education and so on without thinking on the properties of tests such as difficulty indices and discrimination power of test items.

There is therefore need to analyze the difficulty indices and discrimination power in Senior School Certificate Multiple Choice items in Biology. Both WAEC and NECO make use of multiple choice Biology items in their examinations. The researchers also compared the difficulty indices and discrimination power in Senior Secondary School Certificate Multiple Choice items in Biology.

The purpose of the study was to empirically analyze the item difficulty and item discrimination indices of Senior Secondary School Certificate multiple choice Biology tests.

Specifically, the study focused on:

1. item difficulty index of each of the NECO and WAEC SSCE multiple choice Biology tests and
2. item discrimination power of each of the NECO and WAEC SSCE multiple choice Biology test.

Research Questions

This research work investigated the item difficulty indices and item discrimination power of Senior Secondary School Certificate multiple choice items in Biology with view to find the answers to the following research questions:

1. What is the difficulty index of each of the NECO and WAEC SSCE multiple choice Biology tests?
2. What is the discrimination power of each of the NECO and WAEC SSCE multiple choice Biology tests?

Methodology

This study adopted a descriptive survey research design. The population for this study consists of all senior secondary school students in Ekiti State. Ekiti State is one of the states in the South Western part of Nigeria. The state has a largely agrarian economy and most communities engage in growing cash and food crops. Survey research design was chosen for this study because the data were collected through the tests.

The target population for this study consists of senior secondary school three (SS3) students in Ekiti State. Stratified random sampling technique was adopted for the study. The schools were

stratified along three Senatorial Districts in Ekiti State. In Ekiti Central and Ekiti North Senatorial Districts 7 senior secondary schools each were selected while in Ekiti South 6 senior secondary schools were selected. Thus, a total of twenty senior (20) senior secondary schools were selected.

In this study, 576 (40%) respondents were selected from Ekiti Central, followed by Ekiti South, with 466 (32%), while Ekiti North had 408 (28%) respondents. Thus, One thousand four hundred and fifty (1450) students were randomly selected to take part in the study. The researcher adopted the 2008 National Examinations Council (NECO) and West African Examinations Council (WAEC) multiple choice Biology question papers to collect the data. This is because multiple choice tests are the strongest predictors of overall students' performance compared with other forms of evaluation.

2008 WAEC and NECO SSCE multiple choice Biology items have a total of 120 items including 540 options (420 decoys and 120 correct responses). The whole 120 items were reviewed.

The instruments were standardized tests used by these examination bodies in Nigeria and West Africa. These instruments were considered to be accurate and reliable by the public examination bodies.

The data collected from this study were analyzed with respect to the two research questions generated for this study. Item analysis was carried out for research questions 1 and 2 i.e. to obtain the difficulty indices and discrimination power of the test items

Results

Students were asked to indicate whether they were male and female. Their responses are summarized on table 1 below.

Table 1: Distribution of Respondents according to Gender

Gender	**Frequency**	**Percentage**
Male	758	52.3
Female	692	47.7
Total	1450	100.00

In table 1, out of the one thousand four hundred and fifty (1450) students sampled, seven hundred and fifty-eight (758) 52.3% students were males while six hundred and ninety-two (692) 47.7% students were females.

Answers to Research Questions

Research Question One: What is the difficulty index of each of the NECO and WAEC SSCE multiple choice Biology tests?

Item difficulty index of each NECO and WAEC SSCE multiple choice Biology tests were determined by following the CTT principle of selecting the top and bottom 27% of the testees for obtaining this item characteristic. The number of students in the upper and lower groups who got each item right was obtained by frequency count and the proportion getting the items right was calculated. The difficult index obtained was then summarized and presented in grouped frequency distribution tables 2.The researcher used the quality criterion recommended by Tarrant, Ware and Mohammed, (2009) and Theodorsson, Shafil, Wardy, Khan,Mahrezi and Shafaee, (2010) to interpret the difficulty index obtained.

Table 2: Item Difficulty of 2008 NECO and WAEC SSCE Multiple Choice Biology tests Items

Ranges of Difficulty Index	**NECO Frequency**	**%**	**WAEC Frequency**	**%**	**Description**
0 - 14%	1	2	1	2	Very Difficult
15% - 29%	16	26	5	8	Difficult
30% - 69%	40	67	53	88	Moderately Difficult
70% - 84%	1	2	-	-	Easy
85% - 100%	2	3	1	2	Very Easy
Total	60	100%	60	100%	-

Table 2 reveals that in 2008 NECO SSCE multiple choice Biology items, 1 (2%) of the items was very difficult, 16 (26%) of the items were difficult, 40 (67%) of the items were moderately difficult, 1 (2%) of the items was easy and 2 (3%) of the items was very easy.

Also, table 2 reveals that, in 2008 WAEC SSCE multiple choice Biology items, 1 (2%) of the items was very difficult, 5 (8%) of the items were difficult, 53 (88%) of the items were moderately difficult and 1 (2%) of the items was very easy.

Table 3 below compares the mean (x) of item difficulty indices of NECO and WAEC SSCE multiple choice Biology tests items.

Table 3: Comparison of the Item Difficulty in 2008 NECO and WAEC SSCE Multiple Choice Biology Tests Items.

Variable	N	Mean Difficulty
NECO	60	0.40
WAEC	60	0.42

Table 3 shows the comparison of item difficulty in NECO and WAEC SSCE multiple choice Biology test items. From table 3 above, it can be observed that WAEC SSCE Biology items had highest mean difficulty of 0.42 while NECO SSCE Biology items had mean difficulty of 0.40. This shows that WAEC SSCE multiple choice Biology test items have more difficulty items than NECO SSCE multiple choice Biology test items.

Research Question Two: What is the discrimination power of each of the NECO and WAEC SSCE multiple choice Biology tests?

Item discrimination power of each of the NECO and WAEC SSCE multiple choice Biology test items were determined by subtracting the number of the students in the lower group who got the item right from the number of those in the upper group who also got it right and dividing this differences by half of the total number of the testees in the two groups combined. The discrimination index obtained was then summarized and presented in grouped frequency distribution tables 4. The researcher used the quality criterion recommended by Tarrant, Ware and Mohammed, (2009) and Theodorsson, Shafil, Wardy, Khan,Mahrezi and Shafaee, (2010) to interpret the discrimination power obtained.

Table 4: **Discrimination Power of 2008 NECO & WAEC MCT Items in Biology**

Ranges of Discrimination Index	NECO frequency	Percentage	WAEC Frequency	Percentage	Description
-0.00 - 0.18	14	23.3	6	10	Poor
0.19 - 0.29	8	13.3	10	17	Moderate
0.30 - 0.39	9	15	4	7	Good
0.40 - 1.00	29	48.3	40	66	Very Good
Total	60	100%	60	100%	-

Table 4 reveals that 14 (23.3%) of the items were poor, 8 (13.3%) were moderate, 9 (15%) were good and 29 (48.3%) were very good in NECO SSCE Multiple Choice Biology Items .In addition, Table 4 shows that 6 (10%) of the items were poor , 10 (17%) were moderate, 4 (7%) were good and 40 (66%) were very good in WAEC SSCE Multiple Choice Biology Items.

Table 5 below compares the mean (x) of item discriminations in NECO and WAEC SSCE multiple choice Biology test items.

Table 5: Comparison of the Discrimination Power of 2008 NECO and WAEC SSCE Multiple Choice Biology Test Items

Variable	N	Mean Discrimination
NECO	60	0.39
WAEC	60	0.43

Table 5 shows the comparative analysis of NECO and WAEC SSCE multiple choice Biology test items according to the level of item discrimination indices. From the table 5, it can be observed that, WAEC SSCE Biology items had highest mean discrimination of 0.43 while NECO SSCE Biology items had mean discrimination of 0.39. Therefore, WAEC SSCE multiple choice Biology test items have more discriminating items than NECO SSCE multiple choice Biology test items.

Discussion of Findings

It was found that WAEC SSCE multiple-choice Biology test have more difficult items than NECO SSCE multiple choice Biology test. WAEC SSCE multiple choice Biology test have mean difficulty of 0.42 while NECO SSCE multiple choice Biology test have mean difficulty of 0.40. This shows that WAEC SSCE multiple choice Biology test have more difficulty items than NECO SSCE multiple choice Biology test. The findings disagree with the studies of Thorndike and Hagen (1978) and Romans and Stein (1993) which says that, the five (5) option formats have better difficulty indices. The study support the findings of Abiri, (2006) which say difficulty indices of multiple choice test with fewer number of options say four (4) is better than anyone with larger number of options.

The higher mean difficulty index discovered in WAEC may be caused by the number of options in WAEC SSCE multiple choice Biology test. Four option formats in WAEC have higher difficulty than five option formats in NECO. The findings of this study contradicted the findings of Kolawole (2007) which says that there is no significant difference between the difficult levels of WAEC and NECO multiple choice items in mathematics. Therefore, both WAEC and NECO multiple choice tests in mathematics have thesame difficulty levels.

It was found that WAEC 2008 SSCE multiple choice Biology test have more discriminating items than NECO 2008 SSCE multiple choice Biology test. WAEC SSCE multiple choice Biology test have mean discrimination of 0.43 while NECO SSCE Biology test has mean discrimination of 0.39. This shows that WAEC SSCE multiple choice Biology test have more discriminating items than NECO SSCE multiple choice Biology test. This finding is supported by that of finding of Olatunji (2007) that 4 option formats of WAEC SSCE multiple choice tests have better discriminating indices than NECO SSCE multiple choice test in Economics.

Conclusion

The 2008 WAEC SSCE multiple choice Biology test have more moderate difficult items than NECO SSCE multiple choice Biology test. Fewer options (4 options) are better written for

multiple choice Biology test than larger numbers of options say five (5) options. The 2008 WAEC multiple choice Biology test (with 4 options) discriminated better than 2008 NECO multiple choice test (with 5 options). The result of this study should be seen as an indication to teachers, item writers, subject officers, psychometricians and examinations bodies that students' performance can be enhanced positively by adopting the use of fewer options (say 4 options) for multiple choice Biology tests. The findings of this study will help to provide a leeway for solving the problem of mass failure of the candidates faced by the various examination bodies.

Recommendations

Based on the findings and conclusions drawn in this study, the following recommendations are made to relevant educational authorities and examination bodies and other stakeholders in education.

1. 4 option items especially in multiple choice Biology tests should be encouraged but if 5 options items should be used more attention should be given to psychometric properties of tests;
2. Teachers should pay particular attention to principles of test construction and item writing to reduce the problems of item difficulty indices and discrimination power, of multiple choice Biology tests;
3. Governments should periodically organize in-service training programme for teachers on regular basis to broaden their knowledge in test construction, test administration and interpretation in order to improve students' performance in Biology and
4. The two examining bodies should meet and agree on the-same number of decoys of the test items for multiple choice biology items to avoid unnecessary standard comparability.

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