A Comparative Study on Item Characteristics of 2014 – 2016 Mathematics Objective Tests in Junior Secondary School Certificate Examination Questions in Rivers State

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Abstract

The study analyzed and compared the item characteristics of Mathematics Junior Secondary School Certificate Examination (JSSCE) questions from 2014 to 2016 academic sessions. Three research questions were answered in the research study. The research adopted the evaluation and descriptive survey designs. A sample of 1,068 was randomly drawn from 8 Local Government Areas, using multistage sampling approach of purposive, proportionate stratified techniques, but only 1,035 Junior Secondary School 3 students participated in the examination, representing 97% of the sample. The instrument for the study were past 2014 to 2016 JSSCE scripts for Mathematics, each having 60 objective test items.. For data analysis, statistical techniques for calculating item analyses item difficulty, discrimination and distracter indices, we are employed. It was found that based on the criteria set for item analyses, all of the tests had good item difficulty and discrimination indices except 2014 Mathematics test item that had just 23% pass on the difficulty indices criteria and 43% on the discrimination criteria. All of the tests items passed the distracter indices criteria. It was recommended among others, that questions that failed to meet the difficulty, discrimination and distracter indices should be eliminated.
Key words*: item characteristics, item difficulty, item discrimination, distracter indices.*

Introduction

Education is the process that brings about the development of intellectual, physical and emotional qualities of children for them to grow into useful and intelligent citizens. Report from Wikipedia free Encyclopedia (2015) has it that education is formally divided into stages: primary school, secondary school and tertiary school. The Universal Basic Education, which comprises the primary and junior secondary stages of education, was introduced in Nigeria in September 1988 (FRN, 2004). Thus, the Federal Government through the Nigerian Educational Research and Development Council (NERDC) established and initiated the 9-year Basic Education Curriculum (BEC) in schools by rearranging all existing primary and junior secondary school Curricula to achieve the key objectives of the UBE programme. The idea of the 9-year Basic Education Curriculum is centered on acquiring appropriate levels of literacy, numeracy, manipulative, communicative and life-skills in addition to principled, moral and civic values essential for laying a solid foundation for a life time learning as a basis for scientific and philosophical thinking. The Curriculum for the 9-year Basic Education has three sections: Lower Basic Education Curriculum, Middle Basic Education Curriculum and the Upper Basic Education Curriculum. Children are expected to complete primary 6 before they proceed to Junior Secondary School (FRN, 2008).

In the educational system of Nigerian, the Junior Secondary School Certificate Examination (JSSCE) is an exceptional tool. It is an external examination that is conducted by recognized examining bodies such as: the State Ministry of Education and the National Examination Council (NECO). The state ministry of Education conducts JSSCE for state and private – owned secondary schools while NECO conducts that of the Federal owned secondary schools It is meant for year three (3) junior secondary school students who wish to carry on to senior secondary school in state public, private and technical schools in Nigeria (Igbokwe, 2015). It is an essential prerequisite for admission into the senior secondary school: used to appraise the academic attainment of students upon their third year in the junior secondary school; it is also a tool for employment.

The JSSCE covers many subjects irrespective of their status whether they are core, vocational or non vocational subjects, however this study focus on only the JSSCE Mathematics questions. Mathematics is very important in

everyday life, a fundamental discipline for science and technological development; an essential requirement by every intellectual endeavour and advancement of man to manage with the challenges of life. So, Mathematics is the language of the science and the foundation of numeracy, which part of literacy depend on. One who is inactive in mathematical concept is partly of no use to self and the larger society. This is because numeric abilities are the pivot of language in different aspect of life. These are seen in the areas of commerce, education, transport, housing, health, communication and even politics.

In recognition of all these and the nation's quest for technological development, Mathematics was accorded high value and was made a compulsory subject in the school system (Federal Republic of Nigeria, FRN, 2004). Soyemi (1999) opines that Mathematics opens the mind to analytical thinking, logical reasoning and the aptitude for innovative ideas, deep focusing and clarity of thought and precision. It is where all scientific and technological research find their bearings. Studying Mathematics will in no small measure, arm students to live well in our modern age of science and technology" (FRN, 2004). Mathematics therefore is a very important subject which occupies central position in academics. Since Mathematics occupies the central position in academics, it is expected that every student performs very well and pass it in examinations including school-based and external examinations. On the contrary, observations and experiences had revealed that performances of students are never the same across subjects and years in all respects especially in mathematics. Students' performance in an examination is determined by the students' ability levels and the psychometric properties of the test. Hence, to authenticate students' performance in a test, the test must possess some essential psychometric properties. Orluwene and Igwe (2016) defined psychometric property of an examination as "the validity, reliability and item characteristics of the examination". The researchers in this study considered only the item characteristics of the test (Item difficulty, discrimination and distracter indices)

Item characteristics provide information on how each item of the test contributes to the quality of the total test. Hence, they are referred to item statistics because item statistics is the summary description of test takers performance on a particular test item (Wiersma & Jurs 1990). Test consists of different items which may not be of the same quality, some may be flawed while some may not and some may easier while others may difficult. Wiersma & Jurs (1990) opined that easy items that almost every student scored correctly may end up boosting their morale without distinguishing the students based on their ability levels. On the same trend, a very difficult item that no student scored correctly will also end up contributing nothing in distinguishing the students based on their ability levels. Obviously, if a norm reference test fails to distinguish the performance of students based on their ability levels, the aim is defeated and the test does not possess a good quality. It is like a house built with poor quality blocks that will not be strong compare to the one built with good quality block. That means combination of good items in a test leads to the production of high quality test and vice versa.

Test items are the most important or basic blocks for building any good assessment instrument on this note, it is essential that the characteristics of the item be examined before the test administration Item analysis is the re - examination of the responses of items of a test by applying statistical techniques (Hopkins & Antes in Orluwene (2012)**.** That means item statistics is the statistical procedures that are utilized to determine the quality of the test at the item level. These item characteristics are reviewed by the process of item analysis.

In carrying out item analysis, scores of tests are arranged, starting with the highest to the least scores. In practice, the criterion groups of 25% to 33% are taken while the middle papers are discarded (Hopkins and Antes in Orluwene, 2012). Using the classical approach, there are three basics type of item analysis which gives information on the quality of each item in the test. They are

a) Item Difficulty: this is otherwise known as mean performance score for an item. Item difficulty for a dichotomous items under CTT assumption is referred to as P – value, the proportion of test takers getting the item correct while with polychromous items it is simply the average score. So for this study, P – value is used because 2014 – 2016 JSSCE Mathematics objective test are dichotomously scored. In calculating, P - value shows the fraction of students in both the upper and lower ability group that got an item right (Ugodulunwa, 2008). It ranges from 0.0 (none of the students correctly responded to the item) to 1.0 (all responded to the item correctly). The criteria by Sidhu (2005) recommended a difficulty level which range from 0.4 to 0.9. An item that has a low difficulty value of less than 0.4 might have been wrongly keyed, too difficult in comparison to the general level of ability of the class, vague or not written clearly. An item with difficult indices of 1.0 is too easy. This is because interpretation of item difficulty is in reverse form. Thus, the

larger the index the easier the item while the smaller the index the difficult the item. So the item difficulty indices range of 0 -1 is an inverse scale (Wiersma & Jurs, 1990).

b) Item Discrimination: It describes how well an item discriminates between the upper and lower ability group of testees (Ugodunlunwa, 2008). The item- total correlation gives the measure of the discrimination or differentiating power of the item. It is positive if more students from the higher achievers responded to the item correctly more often than low achievers did, and negative if the opposite occurred. It ranges between -1 to +1 and the discrimination is better when the value is closer to 1 while Items with negative discrimination values are very bad items hence should be reviewed and or replaced.

c) Effectiveness of Distracters/Distracters: The distracters are distinctly the incorrect options while the key is the correct option. The distracter should be seem reasonable to an examinee that is not adequately conversant in the content area. Distracter index shows how the incorrect options distract the lower ability grouping from selecting the correct option (key). A good distracter should attract more students from the lower ability group than the upper ability group (Iweka, 2014). The distracter indices range from -1 to +1. A positive value shows that more students in the lower ability group choose it, while a negative value shows that more students in the higher ability group chose it. A zero index indicates that both groups were equally distracted (Orluwene, 2012).

Sequel to this, item analysis is a procedure that examines students' responses to individual test items to evaluate the importance or value of those items and the test itself. It is particularly valuable in improving items that might be sourced in subsequent tests, eliminating vague or misleading ones before the test administration. This analysis is also concerned in reviewing of test item content and statistics which describes testes' performance on the item (Orluwene, 2012). Wiersma and Jurs (1990) stated that when student perform surprisingly low or high, teachers should investigate if the performance level results from error inherent in the test items, instructions or the students' abilities before appropriate action can be taken.

Furthermore observation had shown that students' performance in JSSCE Mathematics varies every year. On a serious note, the level of good or poor performances is not steady but fluctuates yearly with the poor performance having the more prevalence. The variation in the performance of students have been attributed to different factors, some refers it to test characteristics while some others attributed it to personal factor such as ability level. Consequently researches in students' academic performance revealed that sometimes, students' performances in a test are caused by the psychometric properties of a test. For instance, Onunkwo (2002) stated that sometimes, students' failure is because of fault inherent in the psychometric properties of the test, not just due to their own inabilities. This fault in the psychometric properties of test includes among others inclusion of difficult items, items with low or no discrimination power and inadequately numbers of options (Abiri, 2006). The psychometric properties of a test in turn are affected by the number of options in the test item. Specifically, that items with fewer number of options promote better difficulty levels that those with larger number of options. Then Olatunji in Olutola (2015) reported that items with fewer numbers of options discriminated more effectively than those with larger number of options. However, it was observed that JSSCE Mathematics 2014 objective test was five optioned while those for 2015 and 2016 were four options. Considering all these, the problem of this study is therefore to compare the item characteristics of Mathematics in the Junior Secondary School Certificate Examination from 2014 to 2016 academic sessions in Rivers State.

The study is aimed at comparing the item difficulty, discrimination and distracter indices of the items that make up the JSSCE Mathematics questions from 2014 – 2016. It is hoped that from the findings of the study, the psychometric properties of subsequent examination question will be improved upon. The quality of a test is improved when items with good difficulty, discrimination and distracter indices make up a test. To this end, Orluwene (2012) asserted that the quality of a test depends on the quality of individual items of the test. Again, through the findings from the study a better decision about students' performance, teaching and assessment will be achieved. Sometimes decision about the adequacy of students' performance relative to the performance of the norm group or the criterion domain that the test measured are based on the students total score in the test. This method is good but it is not enough because knowing the specific items the student answered correctly gives better and more useful information.

Wiersma and Jurs (1990) stated that when test performance is analyzed at the item level teachers may be able to obtain very specific feedback about student performance which may in turn promote subsequent performance of students and better teaching by the teachers.

Nevertheless, the study will anchor on Classical Test Theory (CTT) which assumes that the students observed score is a combination of true and error scores. CTT is useful for constructing, validating and interpreting norm referenced test. It is also useful for the comparison of students' performance among the group and the assessment of item characteristics (Iweka, 2014).

Research Questions

The study is guided by the following research questions:

1. How adequate are the difficulty indices of objective test items of Mathematics JSSCE questions from 2014 to 2016 in Rivers State, Nigeria?
2. How effective are the discrimination indices of objective test items of Mathematics JSSCE questions from 2014 to 2016 in Rivers State, Nigeria?
3. How effective are the distractive indices of the items in the Mathematics JSSCE objective test items from 2014 to 2016 in Rivers State, Nigeria?

METHODOLOGY

The study adopted the evaluation research design and descriptive survey research. Evaluation design deals with systematic setting of worthwhile goals for passing value judgments based on the set goals, to ascertain whether the objectives should be maintained, modified or improved on. The population of the study is all the 65,054 JSS 3 students of 2016/2017 academic session in junior secondary school 3 in the 280 public secondary schools and approved 397 private secondary schools in the 23 Local Government Areas of Rivers State. A sample of 1,068 junior secondary school students was randomly drawn from 16 selected Junior Secondary Schools in 8 selected Local Government Areas of Rivers State using a multi-stage sampling method.

In stage one purposive sampling technique was employed to select only 18 Local Government Areas out of 23 that have both public and approved private owned secondary schools. At stage two, proportionate stratified random sampling techniques by geographical trim (Riverine and upland) were used to select 6 Local Government Areas from up – land and 2 Local Government Areas from the Riverine areas. Then at the third stage, non – proportionate stratified random sampling technique was used to select 2 secondary schools from each of the 8 Local Government Area selected (1 public school and 1 Private school each). Hence, a total of 16 secondary schools were used for the study. However, at the fourth stage an intact class method was used to obtain a sample of 1068 JSS3 students Past objective Mathematics JSSCE questions from 2014 – 2016 were used for the study, each having 60 objective test items. The Junior Secondary School curriculum and scheme of work were also used to generate data for the study. The instruments are valid instruments verified by experts, used for JSSCE and were constructed by examining bodies as reliable instruments. The instruments (the Mathematics objective test questions for JSSCE in 2014, 2015 and 2016) were administered by the researcher and trained research assistants under the supervision of the researcher to the JSS 3 students in 2016/2017 academic session (an equivalent group to those that wrote the past examinations). The examination was given to the students at the beginning of the third term, so it served as "mock exam" in the preparation for their JSSCE, which they wrote immediately after. Each student answered the Mathematics objective questions for 2014, 2015 and 2016. Out of the sample of 1,068, only 1,035 JSS 3 students participated in the examination, representing 97% of the sample.

The data collected were analyzed using statistical techniques calculating difficulty, discrimination and distracters indices. However, for the purpose of item analysis where only the high and low ability groups are used a sample of 558 students was used in each examination.

Result

After data analysis the result obtain for research questions 1 – 3 were summarised and presented in tables 1 – 3 respectively

Table 1: Summary of difficulty indices of test items of JSSCE Mathematics objective test for 2014 – 2016

Range of difficulty indices	Frequency and percentages of items			Remark
	2014	2015	2016	
Greater than 0.4	14 (23%)	49 (82%)	38 (63%)	Adequate
Less than 0.4	46 (77%)	11 (18%)	22 (37%)	Inadequate

In table 1, it was indicated that JSSCE 2014 Mathematics objective test had 46 (77%) items that were difficult, 14 (23%) items were adequate for JSS 3 students. JSSCE 2015 Mathematics objective test had 11(18%) difficult items and, 49 (82%) were adequate items. For JSSCE 2016 Mathematics objective test, 22(37%) items were difficult 38 (63%) were adequate.

4.2: Summary of the Discrimination Indices of Test Items of JSSCE Mathematics Objective for 2014 - 2016.

Range of discrimination indices	Frequency and percentages of item			Remark
	2014	2015	2016	
0.30 are above	25 (42%)	46 (77%)	46 (77%)	Good
0.20—0.29	23 (38%)	13 (21%)	9 (15%)	Marginal
0.00 – 0.19	11 (18%)	1 (2%)	5 (8%)	Poor
Negative values	1 (2%)	-	-	Bad

In table 2 the JSSCE 2014 Mathematics objective test had 1(2%) item as bad item, 11 items were poor items, while 23 (38%) items were marginal items. The remaining 25 items passed the discrimination indices criteria and represented 42% of the total number of questions constituting the test. In JSSCE 2015 Mathematics objective test, an item was a poor item, while 13 items were marginal items. The remaining 46 items passed the discrimination indices criteria and represented 77% of the total number of questions constituting the test. In JSSCE 2016 Mathematics, 5 (8%) items were poor items, while 9 (15%) items were marginal items. The remaining 46 items passed the discrimination indices criteria and represented 77% of the total number of questions constituting the test. Mathematics objective test for 2015 and 2016 had no item with negative discrimination values.

Table 3: Summary of Distracter indices of test items of JSSCE Mathematics objective for 2014 – 2016.

Range of distracter indices	Frequency and percentages of item			Remark
	2014	2015	2016	
0.05 and above	60 (100%)	57 (95%)	59 (98%)	Effective items
Less than 0.05	_	3 (5%)	1 (2%)	Ineffective items

Table 3 revealed that for 2014 JSSCE Mathematics objective test, all the options in the 60 items passed the distracter indices criteria, representing 100% of the 60 items. In 2015 JSSCE Mathematics objective test, options A, B, D in item 1, options B, C, D in item 2, and options A, B, C in item 43 did not distract effectively. The remaining options in the 57 items passed the distracter indices criteria, representing 95% of the 60 items. For 2016 JSSCE Mathematics objective test, options A, C, D in item 2 did not distract effectively. The remaining options in the 59 items passed the distracter indices criteria, representing 98% of the 60 items.

Discussion of the findings

JSSCE 2014 Mathematics objective test had 46 difficult items out of the 60 items, and thus they are not adequate to the level of the students. The remaining 14 items (23% of the 60 items) were adequate and good for the levels of the students to be included in the test. In JSSCE 2015 Mathematics objective test, 11 items out of the 60 items were difficult hence they are not adequate to the level of the students. The remaining 49 items (82% the 60 items) were adequate and good for the level of the students hence they should be included in the test, which is good. JSSCE 2016 Mathematics objective test had 22 difficult items out of the 60 items, and thus do not qualify to be selected. The remaining 38 items (63% of the 60 items) were adequate and good for the level of the students. All these are in line with the categorizations of Sidhu 2005 that items with difficulty indices ranging between 0.4 and 0.9 are recommended, less than 0.4 are difficult items and greater than 0.9 are too easy. The occurrence of the difficulty items may indicate that there are some flaws/errors in the item. Again it could be that adequate instructions where

not given when teaching the topics that contributed those items that were found to be difficult leading to unfamiliarity of the contents and less knowledge of responding correctly to the items.

In all, it was found that the JSSCE Mathematics question for 2014 have lesser number of items with good difficulty indices when compared to those of 2015 and 2016. JSSCE Mathematics questions, this finding did not support that of Abiri (2006) that reported that fewer number of options promotes better difficulty levels of items then those with larger number of options.

Based on the categorizations of Ebel and Frisbie as documented in Orluwene (2012), items with coefficients greater than 0.40 are very good; between 0.3 and 0.39 are fairly good; between 0.20 and 0.29 are marginal and needs some revision or be eliminated; below 0.19 are poor and need major revision; items with a negative discrimination index are bad and should be eliminated. In JSSCE 2014 Mathematics test an item was bad, 11 items were poor items, while 23 were marginal items. The bad item failed in the discrimination indices criteria, while the 33 (poor and marginal) items need to be reviewed and tried again. The remaining 26 items passed the discrimination indices criteria and represent 43% of the total number of questions constituting the test. The JSSCE 2015 Mathematics objective test had a poor item, while 13 items were marginal. So a total of 14 (poor and marginal) items need to be reviewed and tried again. The remaining 46 (77%) items passed the discrimination indices criteria. In JSSCE 2016 Mathematics Objective test, 5 items were poor, while 9 items were marginal giving a total of 14 poor and marginal items that need to be reviewed and tried again. The remaining 46 (77%) items passed the discrimination indices criteria, so they are good items. In all the was found that items in JSSCE Mathematics objective test discriminated most effectively, followed by those in JSSCE 2016 Mathematics objective test and then 2014 in JSSCE Mathematics objective test. This finding is not in line with that of Olatunji in Olutola (2015) who found that items with fewer number of options discriminated more than those with lager of number options.

Mozaffer and Farhan (2012) recommended that for distracter indices that options should be selected by at least 5% (0.05) of the students from lower ability than the higher ability group. It was found from present study that for 2014 JSSCE Mathematics objective test, all the options in the 60 items passed the distracter indices criteria, representing 100% of the 60 items. The 2015 JSSCE Mathematics had options A, B, D in item 1, options B, C, D in item 2, and options A, B, C in item 43 not distracting effectively. The remaining options in the 57 items passed the distracter indices criteria, representing 95% of the 60 items. For 2016 JSSCE Mathematics objective test, options A, C, D in item 2 did not distract effectively. These options should be changed. The remaining options in the 59 items passed the distracter indices criteria, representing 98% of the 60 items. Mozaffer and Farhan (2012) further agree that distracter index is greatly influenced by item difficulty, since the remaining proportion of a difficulty is shared among the options as distracters. Any distracter that is selected by less than 5% of the students is an ineffective distracter. It is obvious that all the options in the 60 items of the 2014 JSSCE Mathematics distracted effectively. This may be due to the fact that majority of the items were difficult. It was also observed that the JSSCE Mathematics 2014 was 5-optioned, while the JSSCE Mathematics 2015 and 2016 were 4-optioned.

Conclusion

Based on the findings of this study, it was concluded that the Junior Secondary School Certificate Examination (JSSCE) for Mathematics from 2014, 2015 and 2016 vary in the characteristics of their constituent items. This is because based on the criteria set for item analyses, all the tests had good difficulty and discrimination indices. JSSCE 2015 objectives test Mathematics objectives test had the highest internal consistency, the best difficulty and discrimination indices, indicating that it was the best test among the three tests: while the JSSCE 2014 objectives test seems to be made up of more difficulty items.

Recommendations

It was recommended that:

1) The wordings and clarity of the JSSCE test items should be revisited by psychometricians. For example, the correct options in items 43, 44, 45, 46, 49, 50 and 51 of JSSCE 2015 Mathematics.
2) Experts in measurement and evaluation should be used to carry out the rigorous process of item analyses by determining item difficulty, discrimination and distracter indices, not by hand-picking items from past questions.
3) Government should reduce the occurrence of industrial strikes since it negates the adequate coverage of the scheme of work.

4) Questions that failed to meet the difficulty; discrimination and distracter indices should be eliminated or reviewed before their inclusion.
5) Course contents should be covered especially as it concerns Mathematics as a core subject. Teaching methods and instructional materials should be brought to the ability of the students. Teaching should be made more interesting by the teaching relating whatever is taught to everyday life instead of talking in abstract terms.

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