

Original Research Article

Psychometric Analysis of 2018-2020 Basic Education Certificate Examination Mathematics Objective Test Items

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Abstract: The study analyzed the psychometric properties of Mathematics Objective test items in Basic Education certificate examination from 2018 to 2020 academic sessions in Rivers State. Three research questions guided the study; Evaluation and descriptive survey designs were employed for the study. In determining the psychometric properties of the test items, a sample of 1500 JSS3 marked students' scripts were randomly drawn from six Local Governments Areas using the multistage sample approach of purposive and proportionate techniques, out of the population of 19056 JSS3 marked students' scripts in the 105 public secondary schools in the six Local Government Areas in Rivers State. Past mathematics objective test items question papers and JSS1 to JSS3 curriculum and syllabus were used as the instrument for data collection, R. Software was used to calculate the reliability, difficulty indices, discrimination indices and distracter indices, while percentage, frequency and scheme of work were used to ascertain the content validity. The findings indicated that the objective test items content area were not in adequate proportion, the co-efficient of internal consistency was high, Basic Education Certificate Examination 2018 had the highest reliability coefficient. All the test items passed the psychometric properties criteria. It was recommended among others, options that distracted those in the high ability needs to be reviewed for effectiveness in attracting the low ability students, for example item 60 was a bad distracter as it had a negative value. This would improve students' academic performance in Mathematics in Basic Education Certificate Examination in Rivers State.

Keywords: Item characteristic, item difficulty, item discrimination, distracter indices.

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INTRODUCTION

Education in its broadest sense provides the bedrock through which development acquires its meaning. It is the most fundamental and vital aspect of social inquiry and the harnessing of human resources (Ibekwe 2000). According to Fafunwa as cited by Osaat (2011) "Education is the process by which a person develops abilities, skills, attitudes, and other forms of behavior of positive values in the society in which he lives. For Iwe (1991) Education seeks to refine man by developing his potential and equipping him to live meaningfully productively and responsible life in the society. Osaat (2011) defined Education as the process geared towards emancipation of a complete man. That is man will be fully equipped mentally, physically, psychologically, socially, morally etc. to be a useful being whose usefulness will automatically affect his immediate environment and the society at large. Also, Joe- Kinanee and Orluwene (2017) assert that

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.

Education is formally divided into stages: pre-primary school, primary school, secondary school and tertiary school. In Nigeria, the Universal Basic Education scheme was launched in 1999, which was introduced to cater for primary as well as junior secondary levels of education. The primary is to give basic education while the junior secondary is to be prevocational and academic, that is to prepare students for further secondary studies. Upon the introduction of Universal Basic Examination (UBE) programme, the Nigerian Educational Research and Development Council (NERDC) re-structured and realigned all existing primary and Junior Secondary School (JSS) curricula into a 9-year Basic Education curriculum for implementation in Nigerian Schools. The 9-year Basic

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Education curriculum was particularly developed for the attainment of the Education for All (EFA) goals, the critical targets of the National Economic Empowerment and Development Strategies (NEEDS) and the Millennium Development Goals (MDGs). Implementation of the 9-year BEC commenced nationwide, in primary 1 and JSS1 classes in September 2008 respectively. The aim of the curriculum is centered on acquiring appropriate levels of literacy, numeracy, manipulative, communicative and life-skills. In addition, UBE is also to acquire principled, moral and civic values essential for laying a solid foundation for 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 Educational Curriculum, and the Upper Basic Education Curriculum. Children are expected to complete primary 6 before they proceed to Junior Secondary School (FRN, 2008).

For the majority of Nigerians primary education begins at the age of 5 to 6. The pupils spend six years in primary and graduate with a first school leaving certificate with an entrance examination into basic 7 which is the junior secondary school (now basic education). The students spend three years at the junior secondary school level and at the end of the three years; an external examination called Basic Education Certificate Examination is administered to the students.

The Basic Education Certificate Examination (BECE) is a mandatory examination for students in the ninth year of their basic education class and third year of the junior secondary school. The BECE is an external examination conducted by the ministry of education of each state, normally conducted in July/June yearly, the exact date may differ from state to state. It is an examination conducted for students in their final year of Junior Secondary education and who wish to proceed to the senior secondary or any technical college of choice. The curriculum for these also lasts three years and lead to a trade/craftsmanship certificate. Just like other entrance examination in Nigeria with grading system, BECE has its own grading system as follows:

- A – Distinction
- B – Upper credit
- C – Lower credit
- P – Pass
- F – Fail

To pass any subject one must have a grade of at least pass and above. If a student fails English language and mathematics he/she will be made to repeat the BECE in the subsequent year, this is because mathematics and English language are core subjects among others at the basic level of education. However, the study will focus only on mathematics objective test items.

Mathematics, English language, Social Studies and Basic Science and Basic Technology are the 5 core subjects at the junior secondary school level. Mathematics according to Soyemi (1999) opens the mind to analytical thinking logical reasoning and the aptitude for innovative ideas, keep focus and clarity of thought and precision. It is where all scientific and technological research find their bearings. Studying mathematics will in no small measure aim students to live well in our modern age of science and technology. The importance of mathematics cannot be over emphasized, as mathematic is important in everyday life, a fundamental discipline for science and technological development an essential requirement by every intellectual endeavor and advancement of man to cope with the challenge of life. No other subject creates a solid tie among several subdivisions of science as mathematics; without it, information of the science is regularly superficial. Mathematics is the language of science. Literacy goes hand in hand with numeracy. One who is inactive in mathematical competence skills will not only be of use to himself but to the larger society because numeric activities remain the pivot of language in different aspects of your life. These are seen in the areas of commerce, education, transport, housing, health, communication and even politics. These are the reasons the government of Nigeria believes that the subject ought to be seriously taken ton be important in our school system; and Nigeria in her' march towards technological development (Federal Republic of Nigeria, 2004).

However, many students make mathematics their enemy which has among other factors lead to high rate of failure in all external examinations from the common entrance to the SSCE and Unified Tertiary Matriculation Examination (UTME). The dread mathematics phobia and hatred for mathematics predominant in our schools cut across the rank and file of all students even including the apparently high ability students, and the low ability students are not left behind. In spite of all the observations and challenges associated with students' mathematics performance in both internal and external examination, students' performance in an examination is determined by the students; ability levels and the psychometric properties of the test. Thus to ascertain students' performance in a test, the test must possess some essential psychometric properties. Moyinoluwa (2015) attest that the psychometric properties or characteristics of test refer to certain attributes inherent in tests upon which an assessment of candidates is based. These characteristics include the difficulty indices, the discrimination index, the power of distracters, validity and reliability indices. But for purpose of this study, the work would be limited to the difficulty indices, discrimination index and the power of distracters. Most often these test attributes are ignored, it is against this backdrop that the researcher seeks to analyse the psychometric properties of Basic Education Certificate Examination Mathematics

objective test item from 2018 to 2020. Marriott (2002) Dictionary of Statistical Term defined item analysis as analysis based on the responses to individual questions.

Oshkosh (2005) considers test analysis probably as the most important tool to increase test effectiveness. Using the classical approach, there are three basic types of item analysis which goes information on the quality of each item in the test. They are item difficulty, item discrimination and item distracter indices.

Test item characteristics provide information on how each of the tests contributes to the quality of the total test. They are also referred to as item statistics because item statistics is the summary description of test takes performance on a particular test item (Wiersma and Jurs in Orluwene, 2017).

Item difficulty index: is also known as mean performance score for an item. Item difficulty for dichotomous items under CTT assumption is referred to as P-value, the population of test takers getting the item correct while the polychromous items it is simply the average score.

Difficulty index shows the percentage of students (population of students) who answered an item correctly that has been consistently used in measurement is somewhat of a reverse definition. That is the larger the index, the easier the item, the smaller the index, the more difficult the item- Orluwene (2012). For example if an item has a difficulty index (D) of 0.90, this means a very easy test item while a D of 0.020 is a very difficult item. The difficulty index can range from 0 to 1. It is an inverse scale since high D values correspond to easy items and low D correspond to difficult item.

Item Discrimination: It is a measure of whether an item discriminated because students who know the material well and students who don't. Item discrimination reveals the degree to which a test differentiates between the higher ability students and the lower ability students. The higher ability students are those with high scores and answered an item correctly while the lower ability students are those with lower scores and answered an item correctly. For an item to be a good discriminator, it must surely discriminate between the bright and dull student's scores. That is, the bright students will score an item correctly more than the dull students.

Distracter Index: A distracter is an incorrect or wrong or alternative while the key is the correct option. Distracter index shows how the incorrect options distract the lower ability grouping from selecting to correct option (key). They must look good and attractive as if they are the correct answers. The effectiveness of a distracter is determined by comparing

the number of students in the upper and lower ability groups who selected each incorrect alternative (Gronlund in Iweka 2014). A good distracter should distract more students from the lower ability group than the upper ability group (Iweka 2014). This means that the incorrect answer will be attractive to students who do not know the correct answer than those students who know the correct answer. The distracter index ranges from -1.00 to +1.00. A negative distracter value indicates that more of the students in the higher ability group chose it than the lower ability group. This indicates that the distracter is ineffective. A positive distracter value indicates that more of the students in the lower ability group chose it more than those in the higher ability group. This indicates that the distracter is effective. A zero distracter index indicates a situation where both the upper ability group and lower ability group were equally distracted. The higher the discrimination index (D) the better the item discriminated vice versa.

Allen and Yen (2008) observed that the CTT model are procedures for determining item difficulty index, discrimination power and the distracter power of options for understanding and improving the reliability of psychological tests. According to Schnitzer (2008) there are two major controversies associated with testing which stem from two interrelated issues; technical shortcomings in test design and ethical problems in interpretation and application of results. Probably some technical weakness exists in the tests developed and administered by Basic Education Examination Council. Hence there is need to assess the psychometric properties of this examination items. Also item analysis is a procedure that examines students' response 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 reused in subsequent test, eliminating vague or misleading ones before the test administration. When students perform surprisingly low or high teachers should investigate if the performance level results from error inherent in test items, instructions or the students' abilities before appropriate action can be taken. (Wiersma and Jurs, 1990). Onunkwo (2002) asserted 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 discriminating power and inadequately numbers of option (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 numbers of options promote better difficulty levels that those with larger number of options. Then Olatunji in Olutola (2015) reported that items with less number of options discriminated efficiently than those with larger number of options. Also, sometimes there may not be the key to the item among the given option. With all of these,

the problem of the study is to analyze the effectiveness of the psychometric properties of BECE Mathematics.

The findings of this research study would be of significance to the educational sector in Nigeria. Stakeholders in education (teachers, students, principals, BECE, Ministry of Education and Government) will benefit a lot from it. It would function as a reference point to its stakeholders in education in that it will guide them about how a test should be constructed to enhance the performance of test takers. The ministry of education would benefit from this study because they will be harmed with verified data to restructure this examination.

The aim of the study is to analyze the effectiveness of the difficulty, discrimination and the power of distracter indices of objective test items of BECE mathematics from 2018 to 2020. It is hoped that the findings of this study would aid the examination body of BECE improve on the question item so as to improve performance of students. The study would serve as a tool to guide what test items are useful, to be discarded, and reviewed. By these, they would be careful to have just a correct option for every test item, they would also make sure that test items are not too difficult and should be written in simple languages that may not be above the test takers' level of comprehension. It function as a model to correct computation of students' result especially the use of item analyses as indicated in this research. It would make these stakeholders appreciate the job of educational experts in measurement and evaluation on test development, computation of results especially as it concerns BECE.

The principals, by this study, would appreciate the fact that the scheme of work given should be covered by teachers since the course content is what would be used to set BECE. The teachers would in turn do their work well to meet up covering the scheme meant for each course. Government would also ensure that caution is taken to avert the rate of industrial strike action among teachers, which would contribute negatively to the adequate coverage of the scheme/content area. All these would aid to enhance students' performance.

When test performance is analyzed at the item level, teachers may be able to obtain very specific feedback about students' performance which may in turn promote subsequent performance of students and better teaching by the teachers.

However, the study will anchor on Classical Test Theory (CTT) which assumes that the students

observed score is a combination of true and error scores. Iweka, 2014 asserts that CTT is used for constructing, validating and interpreting norm referenced tests. It is also useful for the comparison of students' performance among the group and the assessment of item characteristics.

Research Questions

The following research questions were used to guide the study.

1. How adequate are the difficulty indices of objective test items of mathematics BECE from 2018 to 2020 in Rivers State, Nigeria?
2. What is the discrimination power of the objective test items of mathematics BECE from 2018 to 2020 in Rivers State, Nigeria?
3. How effective are the distractive indices of the items in the mathematics BSCE Objective test items from 2018-2020 in Rivers state, Nigeria?

METHODOLOGY

The study employed the evaluation research design and descriptive survey research. Evaluation research design was used for this study because the data obtained were used to provide feedback on the quality of mathematics BECE. According to Trochim (2006), an evaluation design is the systematic acquisition and assessment of information to provide useful feedback about some objects or issues. The population for this study comprises of all the Junior Secondary School 3 (JSS3) students' marked scripts in 105 public secondary schools which totaled 19056 in the 6 Local Government Areas of Rivers State. A sample of 1500 junior students' scripts was randomly drawn from 6 selected local government areas of Rivers State, with 2 local government representing each senatorial district; using a multi-stage sampling method. The instrument for data collection for this study was the past mathematics objectives test items of the basic education certificate examination (BECE) from the year 2018-2020 conducted by Rivers State Ministry of Education. The student's raw scores from the marked and scored scripts in each of the years were collected from the Rivers State ministry of education, examination and record department. Also the researcher used the BECE mathematics curriculum, syllabus and the scheme of work to generate data for the study.

The data collected were analyzed using the R software in calculating difficulty, discrimination and distracter indices.

RESULT

The results obtained for each research questions are presented in their respective tables below;

Table-1: difficulty indices of BECE mathematics objective test items from 2018 to 2020

Range of difficulty	Frequency and percentage of item			Remark
	2018	2019	2020	
0-0.2	-----			Very difficult
0.21-0.40				Difficult
0.41-0.60	32(53%)	29(48%)	30(50%)	Moderately difficult
0.61-0.80	28(47%)	31(52%)	30(50%)	Easy
0.81-0.1				Very easy

The table above that is BECE2018 mathematics objective test had 32 items that were moderately difficult which represented 53% while 28 items were easy; this represented 47% of the items.

BECE 2019 mathematics objective test had 29 items that were moderately difficult representing 48% of the items and 31 items were also easy items (52%). BECE 2020 Mathematics objective test had 30 items that were moderately difficult (50%) and also 30 items that were easy, also representing 50% of the test items.

Table-2: discrimination indices of BECE Mathematics objective test items from 2018 to 2020

Range of discrimination indices	Frequency and percentage of items			Remark
	2018	2019	2020	
0.40 and above	10(17%)	1(2%)	10(16%)	V. Good
0.30-0.39	26(43%)	30(50%)	25(42%)	Good
0.20-0.29	15(25%)	11(18%)	16(27%)	Marginal
0.00-0.19	8(13%)	9(15%)	8(13%)	Poor
Negative value	1(2%)	9(15%)	1(2%)	Bad

Table 2 BECE 2018 had 1(2%) item as bad, 8(13%) items were poor, 15(25%) items were marginal, 26 (43%) items were reasonably good but possibly need improvement. While 10(17%) items were very good items that needed neither improvement nor revision as they discriminate perfectly well.

BECE 2019 showed that 9(15%) items were bad, 9(15%) items were poor, 11(18%) items were marginal, 30(50%) items were reasonably good while 1(2%) item was very good. BECE 2020 showed that 1(2%) item was bad, item, 8(13%) items were poor, 16(27%) was marginal, 25(48%) items were reasonably good, and 10 items were very good.

Table-3: Distracter indices of test items of BECE Mathematics objective test items from 2018 to 2020

range of distracter values	Frequency and percentage of items			Remark
	2018	2019	2020	
0.5 and above	55(92%)	55(92%)	55(92%)	Effective
less than 0.5	5(8%)	5(8%)	5(8%)	Ineffective

Table 3 showed that for 2018 BECE Mathematics objective test, options b, c, e in item 1 and options a, b and e in item 2 did not distract effectively. Also all the options in item 4 and item 34 did not distract effectively. The rest of the options in the 55(92%) items passed the distracter indices criteria. In 2019 BECE mathematics objective test, item 1 and 22 were not distracters at all because these items did not have keys to the items, while the remaining 55(92%) items distracted effectively. In 2020 BECE mathematics objective test, 5(8%) items were ineffective, while 55 items were effective that represented 92% of the test items.

In BECE 2018 Mathematics objective test items, had 38 items out of the 60 items were moderately difficult. These items represented 53% of the test items; they were adequate for the level of the students. The remaining 28 items representing 47% of the test items were easy items, they are to be revised for further usage. In BECE 2019 mathematics objective test items had 29 items (48%) were moderately difficult and 31 items (52%) were easy items, need to be revised. BECE 2020 had equal items moderately difficulty 30 items and 30 items as easy items. All the items under the 3 years of review meet up the criteria for item difficulty; hence the study had good difficulty indices. All these are in line with Sidhu 2005 that opined that items with difficulty ranging between 0.4 and 0.9 are recommended, since there was no item with less than 0.4, all items were recommended.

DISCUSSION OF THE FINDINGS

The results from table 1, based on the categorizations of Sidhu as documented in Orluwene (2012), that items with coefficients ranging between 0.4 and 0.9 are recommended, less than 0.4 are difficult items and greater than 0.9 are too easy items, thus:

The results from table 2, was based on the categorizations of Ebel and Frisbie as documented in

Orluwene (2012), that 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 eliminated; below 0.19 are poor and need major revision; items with a negative discrimination index are bad and should be eliminated. Hence; in BECE 2018, 1 item was bad which should be eliminated; 8 items were poor, 15 items were marginal items. These 23 items need to be reviewed and tried again. While 26 items were good and 10 items were very good. These 36 items passed the discrimination indices criteria and represent 60% of the total number of items that constituted the test. In 2019 BECE, 9 items were bad which should be eliminated. 9 items were poor and 11 items were marginal items. These 20 items need to be reviewed and tried again. While 29 items were good and 2 items were very good. Hence, 31 items out of the 60 items meet up the discriminating criteria. In 2020 BECE, only 1 item was bad which should be eliminated. 8 items were poor, and 16 items were marginal. These 24 items need to be reviewed and tried again. 25 items were good and 10 items were very good. A total of 35 items representing 58% of the total number of test items.

Based on the recommendations of Mozaffer and Farhan (2012) for distracter indices, options selected by at least 5% (0.05) of the students. Table 3 indicated that, BECE 2018 mathematics, options b, c, e in item 1 and options a, b and e in item 2 did not distract effectively. Also all the options in item 4 and item 34 did not distract effectively. These options should be changed. The rest of the options in the 55 items passed the distracter indices criteria which represented 92% of the 60 items. BECE 2019 mathematics objective test items showed that item 1 and 22 were not distracters at all because these items were bonus question, as there was no correct response (key) which mean that every student got it right. Also items 2, 3, and 4 options were ineffective which represented 8% of the test items, while the remaining 55 items distracted effectively which represented 92% of the test items. Hence the test had good distracter. In BECE 2020 mathematics objective test items, 5 items were ineffective, this represented 8% of the test items while 55 items were effective that represented 92% of the test items.

Mozaffer and Farhan (2012) further opined 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. In all of these three years under study, 55 items representing 92% of the items passed the distracter indices criteria, indicating that BECE mathematics objective test items from 2018 to 2020 distracted effectively.

CONCLUSION

Based on the findings of the study, it was concluded that BECE mathematics objective test items had good difficulty and discrimination indices. Also the test items passed the distracter indices criteria. Though they vary in their characteristics constituents.

RECOMMENDATION

Recommendation for this study is based on the results of the findings which are as follows:

1. Questions that failed to meet the difficulty, discrimination and distracter indices should be eliminated.
2. Care should be taken to ensure that test options are arranged in order, so that the testees and the markers would not be confused. Take for instance, items 1 and 22 in 2019 BECE mathematics did not have the correct key.
3. Options that distracted those in the high ability needs to be reviewed for effectiveness in attracting the low ability students, for example item 60 was a bad distracter as it had a negative value.

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