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Items Analysis of Mathematics Basic Education Certificate Examination in Junior Secondary Schools Before and After Covid-19 Lockdown in Sokoto State

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Abstract

The study conducted an items analysis of the 2019 and 2021 Mathematics basic education certificate examinations (BECE) in junior secondary schools in Sokoto state. The objective of the study is to assess the a, b, and c- parameters of the 2019 and 2021 basic education certificate examinations Mathematics. Six (6) research questions were raised and answered. Ex-post- facto research design was adopted. The population of the study was 13,486 and 13,995 students registered and sat for the 2019 and 2021 BECE Mathematics respectively. Out of which 500 sample from each of the 2019 and 2021 BECE was determined via Item Response Theory for Patient Reported Outcome (IRT-PRO) models with 3PL recommendation. Multi-stage cluster sampling technique was used in this research. Item analysis was performed via the use of IRTPRO software, and conventional statistical analysis using descriptive statistical analysis. The findings revealed that the 2019 basic education certificate examinations Mathematics objective test items had adequate discrimination and difficulty indices. The test also showed that the majority of the items had passed the distracter indices criteria. The findings however revealed that the 2021 basic education certificate examinations Mathematics shows that both discrimination and difficulty indices were adequate. And also, the majority of the item passed the distracter indices criteria. The study therefore recommended among others that: government and private schools proprietors should endeavour to sponsor teachers, especially in the examination offices for conferences, workshops and seminars.

Keywords: Items Analysis, Basic Education Certificate Examinations (BECE), Mathematics, Junior Secondary Schools, Covid-19.

Introduction

The level of development in any nation is ascertained via the outcome of its education policies either in terms of the product from the educational sector or other assessment parameters (Bassey, Jacob & Nobel, 2022). According to (Anaman et al, 2022) education is the essential building block for societal, economic, scientific and technological progress. Thus, education at the basic level should be the foundation for senior secondary school level and higher knowledge in tertiary institutions.

The prevalent Nigerian educational system seems to be far from achieving the desired educational goals and objectives as there is noticeable evidence of the decline in the

standard of education, evidenced by poor and fluctuating results in public examinations. This evidence is clear in internal and external examinations, especially in Mathematics subject.

Ohanyelu (2021) stated that the academic performance of students in Mathematics among public secondary schools in Nigeria has consistently been low over a period. For several years now, research findings have shown the abysmal performance of students of secondary schools in public examinations (Ogunbanwo, 2014). However, total success is a concern to educational administrators, test experts, students, parents, and the examination body as well. In recent times, the poor performance of secondary school students in mathematics has become a source of worry for educational researchers, policymakers, parents, and other stakeholders (Ohanyelu, 2021).

Obarasua and Orluwene (2022) elucidated that, 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. Thus, students must possess at least a credit pass in English language, Mathematics, and any other three subjects before they are admitted into senior secondary school.

For Nigeria to advance technologically and improve its socio-economic status, Mathematics education at the basic level should be well managed (Hussaini, 2023).

The present world of post Covid-19 era has changed the mind-sets of the people about the entire global educational system; teaching, learning, and assessment alike (Hussaini & Bello, 2023). Thus, the Covid-19 pandemic has created challenges and caused disruption across the entire educational system tests included. Learning from our student experience during the Covid-19 period will help us shape our future (Bashir, et al, 2021).

The Covid- pandemic has already reshaped how people do business from now on. According to (Kofi, 2020) some of the strategies that academic institutions have used during this pandemic should be modified more radically.

Item analysis is a process that examines students' responses to individual test items (multiple-choice questions) to assess the quality of those items. According to (Hussaini, 2023) item analysis is a technique in which both students' responses and test items are examined to assess the quality of the items and the test as a whole. According to Krishnan (2013). Item analysis broadly refers to the specific methods used to evaluate items on a test, both qualitatively and quantitatively, to evaluate the quality of individual items. Anikweze (2012) stated that the outcome of item analysis helps teachers and test developers improve on item selection for the test by eliminating unreliable items, substituting for poor items, or recasting poorly stated questions for better effect.

According to Arora (2018), item analysis consists of the following three aspects:

a. Difficulty index
b. Discrimination index

c. Distracter effectiveness

Difficulty index or easiness index: A measure of whether an item was too easy or too hard.

Discrimination index: A measure of whether an item discriminated between students who knew the answer and students who did not.

Distracter effectiveness: Determination of whether distractors (incorrect but plausible answers) tend to be marked by the less able students and not by the intelligent students.

The difficulty index (p):

i. Between 50 and 60% are considered good
ii. 30–70% is acceptable
iii. Above 70% or below 30% require modification.

The discrimination index (d):

i. 0.35 and above are considered excellent
ii. 0.25 to 0.34 are good,
iii. 0.20 to 0.24 are acceptable and
iv. Below 0.20 require modification.

The Pseudo-guessing (*c*)

According to Ayanwale, Adeleke and Mamadelo (2018) the *c*- parameter has a theoretical range of $0 \leq c \leq 1.0$, but in practice, values above 0.35 are not considered acceptable, hence the range $\theta \leq c \leq 0.35$ is usually adopted when the 3- parameter logistic model is used.

The Objective of the Study

The objective of the study is to assess *a, b and c*- parameters (discrimination, difficulty and guessing indices) of the 2019 and 2021 BECE Mathematics in junior secondary schools in Sokoto state (before and after the Covid-19 lockdown).

Research Questions

The following research questions were raised to guide the study:

i. What is the *a*-parameter (discrimination parameter) of the 2019 BECE Mathematics in junior secondary schools in Sokoto state (before the Covid-19 lockdown)?
ii. What is the *b*- parameter of the 2019 BECE Mathematics in junior secondary schools (before the Covid-19 lockdown) in Sokoto state (difficulty parameter)?
iii. What is the *c*- parameter (guessing parameter) of the 2019 BECE Mathematics in junior secondary schools in Sokoto state (before the Covid-19 lockdown)?
iv. What is the *a*- parameter (discrimination parameter) of the 2021 BECE Mathematics in junior secondary schools in Sokoto state (after the Covid-19 lockdown)?

v. What is the *b*- parameter (difficulty parameter) of the 2021 BECE Mathematics in junior secondary schools in Sokoto state (after the Covid-19 lockdown)?
vi. What is the *c*- parameter (guessing parameter) of the 2021 BECE Mathematics in junior secondary schools (after the Covid-19 lockdown) in Sokoto state?

Significance of the Study

This study is anticipated to increase the existing literature on item analysis (3PL), especially during the Covid-19 pandemic era. However, it is expected that this study will enable test constructors of various states ministries of education and other examination body to make appropriate use of item analysis procedures to judge the quality and worth of test items.

Statement of the Problem

The performance of students in BECE Mathematics examinations varies from person to person and it may be credited to the fact that the tests are too simple or too difficult. Examinations (tests) are often constructed and administered by classroom teachers and test developers from examination departments with little or no concern about the quality of what every measurement should possess. Issues of level of difficulty of the items, discrimination index and probability of testees to guess the right answer correctly seem to be overlooked.

However, many reasons could be credited to the good performance, these include; the simplicity of the items, the inability of the items to satisfy the criteria of a good test as well as the inability of the items to conform with item-writing procedures. Consequently, a well-standardized test should not be too difficult or too simple. It should be able to discriminate effectively between high-ability students and low-ability students.

Many students make Mathematics subject their enemy which has among other factors lead to a high rate of failure in all external examinations (Obarasua & Orluwene, 2022). Equally, the trends in the performance of students in Mathematics at the Basic Education Certificate Examination administered by the examination department of the Sokoto State Ministry for Basic and Secondary Education show that examinees' performance is consistently fluctuating over the years. They isolated various factors that could mar examinees' performances in Mathematics. Nature of the test items is noticeable among these factors.

The investigators believe that it is significant to investigate the quality of the items in the 2019 and 2021 BECE Mathematics multiple choice in junior secondary schools in Sokoto state before and after the Covid-19 lockdown to see whether there is a difference in *a*, *b* and *c*- parameters.

Theoretical Framework

Ayanwale, Adeleke and Mamadelo (2018) stated that there are two main frameworks through which quality test items can be achieved in educational measurements. They are the Classical Test Theory (CTT) and Item Response Theory (IRT). For this research, the item response theory (IRT) is employed.

Item Response Theory (IRT)

According to Hambleton (1994), IRT is a statistical theory comprised of a variety of Mathematical models that have the following characteristics: a- to predict person's scores based on his/her abilities or latent traits and b- to establish a relationship between person's item performance and the set of traits underlying item performance through a function called the "item characteristic curve". These characteristics are possible because IRT models provide item and ability parameter invariance for test items and persons, when the IRT model of interest fits the available test data. In other words, the same items used in different samples will keep their statistical properties (for instance, difficulty and discrimination).

The characteristics of item response models as summarised by Hambleton and Swaminathan (1985) are first, an IRT model must specify the relationship between the observed response and underlying unobservable construct. Secondly, the model must provide a way to estimate scores on the ability. Thirdly, the examinee's scores will be the basis for the estimation of the underlying construct. Finally, an IRT model assumes that the performance of an examinee can be completely predicted or explained by one or more abilities. In item response theory, it is often assumed that an examinee has some latent, unobservable trait (also called ability), which cannot be studied directly. The purpose of IRT is to propose models that permit linking this latent trait to some observable characteristics of the examinee, especially his/her faculties to correctly answering to a set of questions that form a test (Magis, 2007).

Item Response Theory's item parameters include difficulty (location), discrimination (slope), and pseudo-guessing (lower asymptote). The three most commonly used IRT models are; one parameter logistic model (1PLM or Rasch model), the two-parameter logistic model (2PLM) and the three-parameter logistics model (3PLM). All three models have an item difficulty parameter (*b*), In addition, the 2PL and 3PL models possess a discrimination parameter (*a*), which allows the items to discriminate differently among the examinees. The 3PL model contains a third parameter, referred to as the pseudo-chance parameter (*c*). The pseudo-chance parameter (*c*) corresponds to the lower asymptote of the item characteristic curve (ICC) which represents the probability that low-ability test takers will answer the item correctly and provide an estimate of the pseudo parameter (Embretson & Reise, 2000).

According to Ani (2014), IRT models are described by the number of parameters they use in revealing item information. The three-parameter logistic (3PL) model is named so because it employs three-item parameters. That is item difficulty, discrimination and guessing parameters.

The equation for the three-parameter model is:

$$(\theta) = Ci + (1 - Ci)\ \frac{eD(O - bi)}{1 + e\,(((\theta - bi))}$$

Where:

b is the difficulty parameter

a is the discrimination parameter
c is the guessing parameter and
$è$ is the ability level

Assumption of Item Response Theory

There are four (4) major assumptions of the IRT as identified by (Warm, 1978). The first assumption states that if an examinee knows the correct response to an item he/she will go ahead to answer it correctly. This assumption relates to assumptions in any test theory. The other three assumptions are; local independence, unidimensionality and item response function (i.e. item characteristics curve ICC).

Literature Review

Many studies have been carried out on assessing the quality of multiple-choice items. For instance, Obarasua and Orluwene (2022) psychometric analysis of the 2018-2020 basic education certificate examination Mathematics objective test items. The findings indicated that all the test items passed the psychometric properties criteria. In another development, Ibrahim (2018) in a study psychometric analysis of the 2016 Mathematics, basic education certificate examination in Gombe state, Nigeria. The study used item response theory (IRT) to examine item difficulty, discrimination and probability of guessing values. Findings from the study revealed that 52 out of the 60 items were easy; the items discriminated well between the high and low-ability groups of students that took the test whereas many items showed a high probability to guessing.

However, in a study by Alfanda, (2019) item analysis of the 2014 English language senior Arabic and Islamic secondary school certificate examination (SAISSCE) in the Kano municipal education zone, Kano. The study findings revealed 57 out of the 70 items in the examination are easy items, with only 13 items found to be difficult; items discriminated well among examinees, whereas many items showed a very low probability of guessing with only 20 items exhibited high guessing values.

In another research, Ogechukwu, (2018) psychometric properties analysis of basic certification examination for French multiple choice test items of the 2013, 2014, and 2015 in Anambra state. The findings show that the difficulty indices for the basic education certificate examination for French multiple-choice test items had acceptable difficulty indices for all the years under investigation, i.e. 2013 63%, 2014 70, % and 2015 72%. The analyses of discrimination indices revealed that, for 2013 63% discriminated well, 10% showed negative while 27% did not discriminate well. For 2014 75% of the French multiple-choice test items discriminated well while 25% did not and for 2015 62% of the French test items discriminated well and 38% did not.

Moreover, Toyin (2015) in a study analyzing the psychometric properties of Mathematics in public examinations in Nigeria involved all the SS III students at the final stage of their preparation for WAEC and NECO, SSCE as well as NABTEB papers. The findings indicated WAEC, NECO, NABTEB, and JAMB developed tests covering not less than 80% of their

syllabi content and also a fairly high proportion of the test items have appropriate difficulty index i.e. within the range of 0.25 – 0.75. However, findings shoes that, the functionality of the distracters is best in JAMB multiple-choice items and least in NECO but in general terms, the distracters showed a fairly good combination of options.

Methodology

Research Design

An ex-post facto research design was adopted for this research. This is because the nature of the independent variables; school type, and students' academic performance obtained cannot be manipulated. According to Salkind (2010), ex post facto study or after-the-fact research is a category of research design in which the investigation starts after the fact has occurred without interference from the researcher.

Population

The population of this study was 13,486 and 13,995 students which comprise all students who registered and sat for the 2019 and 2021 Mathematics Basic Education Certificate Examinations (BECE) in junior secondary schools in Sokoto state respectively before and after the Covid-19 lockdown.

Sample Size

A sample of 500 units of analysis was selected from each of the 2019 and 2022 BECE Mathematics. From a theoretical perspective, IRT models with more parameters require a greater sample size than models with fewer parameters. Smaller sample sizes are required with the Rasch Model, a one-parameter model, than is the case with the two-parameter or three-parameter models, usually starting from 500, 1000 to 2000 examinees (Edelen & Reeve, 2007; Bond & Fox, 2007; Morizot, Ainsworth, & Reise, 2007).

Sampling Technique

A multistage sampling technique was employed for this study.

Statistical Tools

Item analysis and conventional statistical analysis were used by the researchers for analyses and data interpretation. Item analysis (indices of statistical parameters) via (IRTPRO), Scientific Software International, Inc (SSI) was used in determining the item parameters and answering the research questions.

Data Presentation and Findings

Research Question 1: What is the *a-parameter* (discrimination parameter) of the 2019 BECE Mathematics in junior secondary schools (before the Covid-19 lockdown) in Sokoto state?

Table 1: Item Parameter *a*- Estimates of the 2019 BECE Mathematics in Junior Secondary Schools (before Covid-19 lockdown) based on 3the PL Logistic Model

Item No.	Estimate	Item No.	Estimate	Item No.	Estimate	Item No.	Estimate
1	1.06	6	24.38	11	2.12	16	30.28
2	24.38	7	1.92	12	3.19	17	3.97
3	0.87	8	2.10	13	30.28	18	29.87
4	1.86	9	1.49	14	3.73	19	1.10
5	1.04	10	29.87	15	2.24	20	2.21

The parameter *a*- was estimated by running the person-by-item matrix on the 2019 BECE Mathematics in junior secondary schools via the IRTPRO package. The output was extracted and presented in Table 1. However, the decision was guided by the parameter *a*- guidelines presented in the table as suggested by Baker (2001) and Demars (2010).

Table 1b: Labels for *a*- Parameter Values of the 2019 BECE Mathematics in Junior Secondary Schools (before Covid-19 lockdown) based on the 3PL Logistic Model

Category	Number of Items	%
None ≤ 0	0	0
Very Low .01-.34	0	0
Low .35-.64	0	0
Moderate .65-1.34	4	20
High 1.35-1.69	1	5
Very High ≥ 1.7	15	75
Total	**20**	**100**

Table 1b depicts the summary of the labels for *a*- parameter estimate of the 2019 BECE Mathematics in junior secondary schools (before the Covid-19 lockdown). From the table, it can be seen that 0 of the items fall under none (≤ 0) value representing 0%. The items that fall under very low (.01-.34) values are also 0 representing 0%. However, 0 items account for low (.35-.64) values representing 0%. The items that fall under moderate (.65-1.34) values are 4 (1, 3, 5, and 19) representing 20%. Moreover, 1 item falls under high (1.35-1.69) values and the item is item 9 representing 5%. Fifteen (15) of the items are within the very high (≥ 1.7) values. Hence, these items are 2, 4, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18 and 20.

Research Question 2: What are the *b*- parameter (difficulty parameter) estimates of the items on the 2019 BECE Mathematics in junior secondary schools?

Table 2: Item Parameter *b*- Estimates of the 2019 BECE Mathematics in Junior Secondary Schools (before Covid-19 lockdown) based on the 3PL Logistic Model

Item No.	Estimate	Item No.	Estimate	Item No.	Estimate	Item No.	Estimate
1	-2.29	6	0.12	11	-0.70	16	-0.39

2	0.12	7	-0.65	12	-0.64	17	-0.29
3	-2.43	8	-0.57	13	-0.39	18	0.62
4	-0.83	9	-0.42	14	-0.44	19	-1.44
5	0.06	10	0.62	15	-0.19	20	-0.46

Table 2 presents item parameter *b*- values of the 2019 BECE Mathematics items (before the Covid-19 lockdown) based on the three-parameter logistic (3PL) model. The parameter *b*- was estimated by running the person-by-item- matrix via the IRTPRO package. However, the decision is based on the values within the range of -3 to +3 as suggested by Baker (2001) and Demars (2010) in the table 2b.

Table 2b: Labels for *b*- Parameter Estimates of the 2019 BECE Mathematics in Junior Secondary Schools (before Covid-19 lockdown) based on the 3PL Logistic Model

Category	Number of Items	%
Difficult Items	5	25
Easy Items	15	75
Total	**20**	**100**

From the table 2b, it can be seen that 5 items are within the *b*-value range of +3 and have positive difficult estimates while 15 items are within the *b*-value range of -3 and have negative difficulty estimates. The negative estimate implies that 15 items are easy while 5 items are difficult. As per as the labels of the *b*- parameter is concerned it however revealed that a minority of the items (5) items are difficult representing 25% and the items are: 2, 5, 6, 10 and 18. However, 15 items are difficult representing 75% and these items are 1, 3, 4, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19 and 20 respectively.

Research Question 3: What are the *c*-parameter (guessing parameter) estimates of the items on the 2019 BECE Mathematics in junior secondary schools (before the Covid-19 lockdown)?

Table 3: Item Parameter *c*- Estimates of the 2019 BECE Mathematics in Junior Secondary Schools based on the 3PL Logistic Model

Item No.	Estimate	Item No.	Estimate	Item No.	Estimate	Item No.	Estimate
1	2.42	6	-2.87	11	1.49	16	11.69
2	-2.87	7	1.26	12	2.03	17	1.14
3	2.12	8	1.20	13	11.69	18	-18.51
4	1.54	9	0.63	14	1.63	19	1.58
5	-0.06	10	-18.51	15	0.42	20	1.02

The parameter *c*- was estimated by running the person-by-item-matrix on the 2019 BECE Mathematics via the IRTPRO package. However, the decision was guided by the parameter *c*- guidelines presented in Table 3b as suggested by Baker (2001) and Demars (2010).

Table 3b: Labels for *c*-Parameter Values of the 2019 BECE Mathematics in Junior Secondary Schools (before Covid-19 lockdown) based on the 3PL Logistic Model

Category	Number of Items	%
Very Low -0.00 & below	5	25
Low 0.01-0.25	0	0
High 0.26 & above	15	75
Total	**20**	**100**

Table 3b portrays the summary of the labels for *c*- parameter estimates. The outcome from the analysis indicated that 5 out of the 20 items have very low guessing values that range between (-0.00 & below), representing 25% and these items are: 2, 5, 6, 10 and 15 which implies that the chance of getting an answer correctly by mere guessing is very low. 0 item has a low value that ranges from (0.01-0.25), and 15 items (75%) fall under the range of 0.26 and above as the high category. Thus, these items are 1, 3, 4, 7, 8, 9, 11, 12, 13, 14, 16, 17, 18, 19 and 20. By implication, it means that the chance of getting an answer correctly by mere guessing is high regarding these items.

Research Question 4: What is the *a*-parameter (discrimination parameter) of the 2021 BECE Mathematics in junior secondary schools (after the Covid-19 lockdown) in Sokoto state?

Table 4: Item Parameter *a*- Estimates of the 2021 BECE Mathematics in Junior Secondary Schools (after Covid-19 lockdown) based on the 3PL Logistic Model

Item No.	Estimate	Item No.	Estimate	Item No.	Estimate	Item No.	Estimate
1	0.89	6	0.61	11	1.79	16	1.36
2	0.61	7	0.90	12	2.72	17	3.29
3	1.18	8	1.31	13	1.36	18	21.66
4	1.35	9	1.38	14	1.98	19	4.50
5	6.34	10	21.66	15	2.98	20	18.18

The parameter *a*- was estimated by running the person-by-item matrix on the 2021 BECE Mathematics in junior secondary schools via the IRTPRO package. The output was extracted and presented in Table 4. However, the decision was guided by the parameter *a*-guidelines presented in Table 4b as suggested by Baker (2001) and Demars (2010).

Table 4b: Labels for *a*- Parameter Values of the 2021 BECE Mathematics in Junior Secondary Schools (after Covid-19 lockdown) based on the 3PL Logistic Model

Category	Number of Items	%
None ≤ 0	0	0
Very Low .01-.34	0	0

Low .35-.64	2	10
Moderate .65-1.34	4	20
High 1.35-1.69	4	20
Very High ≥ 1.7	10	50
Total	**20**	**100**

Table 4b depicts the summary of the labels for *a*- parameter estimate of the 2021 BECE Mathematics in junior secondary schools (after the Covid-19 lockdown). From the table, it can be seen that 0 of the items fall under none (≤ 0) value representing 0%.
The items that fall under very low (.01-.34) values are also 0 representing 0%. However, 2 items (1, 6) account for low (.35-.64) values representing 10%. The items that fall under moderate (.65-1.34) values are 4 (1, 3, 7, and 8) representing 20%. Moreover, 4 item also falls under high (1.35-1.69) values and the item is item 4, 9, 13 and 16 representing 20%. Ten of the items are within the very high (≥ 1.7) values. Hence, these items are 5, 10, 11, 12, 14, 15, 17, 18, 19 and 20.

Research Question 5: What are the *b*- parameter (difficulty parameter) estimates of the items on the 2021 BECE Mathematics in junior secondary schools?

Table 5: Item Parameter *b*- Estimates of the 2021 BECE Mathematics in Junior Secondary Schools (after Covid-19 lockdown) based on the 3PL Logistic Model

Item No.	Estimate	Item No.	Estimate	Item No.	Estimate	Item No.	Estimate
1	-3.12	6	-2.79	11	-0.88	16	-0.58
2	-2.79	7	-1.45	12	-0.55	17	0.16
3	1.67	8	-1.41	13	-0.58	18	1.72
4	-1.79	9	-0.74	14	-0.48	19	0.35
5	1.87	10	1.72	15	-0.37	20	0.24

Table 5 presents item parameter *b*- values of the 2021 BECE Mathematics items (after the Covid-19 lockdown) based on the three-parameter logistic (3PL) model. The parameter *b*- was estimated by running the person-by-item- matrix via the IRTPRO package. However, the decision is based on the values within the range of -3 to +3 as suggested by Baker (2001) and Demars (2010) in the table 5b.

Table 5b: Labels for *b*- Parameter Estimates of the 2021 BECE Mathematics in Junior Secondary Schools (after Covid-19 lockdown) based on the 3PL Logistic Model

Category	Number of Items	%
Difficult Items	7	35
Easy Items	13	65
Total	**20**	**100**

From the table 5b, it can be seen that 7 items are within the *b*-value range of +3 and have positive difficult estimates while 13 items are within the *b*-value range of -3 and have negative difficulty estimates. The negative estimate implies that 13 items are easy while 7 items are difficult. As per as the labels of the *b*- parameter is concerned, table 2b revealed that a minority of the 7 items are difficult items representing 35% and the items are 3, 5, 10, 17, 18, 19 and 20. However, 13 items are easy representing 13% and these items are 1, 2, 4, 6, 7, 8, 9, 11, 12, 13, 14, 15 and 16 respectively.

Research Question 6: What are the *c*- parameter (guessing parameter) estimates of the items on the 2021 BECE Mathematics in junior secondary schools (after the Covid-19 lockdown)?

Table 6: Item Parameter *c*- Estimates of the 2021 BECE Mathematics in Junior Secondary Schools based on the 3PL Logistic Model

Item No.	Estimate	Item No.	Estimate	Item No.	Estimate	Item No.	Estimate
1	2.77	6	1.70	11	1.58	16	0.78
2	1.70	7	1.31	12	1.51	17	-0.53
3	-1.97	8	1.85	13	0.78	18	-21.67
4	2.42	9	1.02	14	0.94	19	-1.58
5	-11.87	10	-21.67	15	1.10	20	-28.14

The parameter *c*- was estimated by running the person-by-item-matrix on the 2021 BECE Mathematics via the IRTPRO package. However, the decision was guided by the parameter *c*- guidelines presented in Table 3b as suggested by Baker (2001) and Demars (2010).

Table 6b: Labels for *c*-Parameter Values of the 2021 BECE Mathematics in Junior Secondary Schools (before and after Covid-19 lockdown) based on the 3PL Logistic Model

Category	Number of Items	%
Very Low -0.00 & below	7	35
Low 0.01-0.25	0	0
High 0.26 & above	13	65
Total	**20**	**100**

Table 6b portrays the summary of the labels for *c*- parameter estimates. The outcome from the analysis indicated that 5 out of the 20 items have very low guessing values that range between (-0.00 & below), representing 25% and these items are: 3, 5, 10, 17, 18, 19 and 20 which implies that the chance of getting an answer correctly by mere guessing is very low. 0 item has a low value that ranges from (0.01-0.25), and 15 items (75%) fall under the range of 0.26 and above as the high category. Thus these items are 1, 2, 6, 7, 8, 9, 11, 12, 13, 14, 15

and 16. By implication, it means that the chance of getting an answer correctly by mere guessing is high regarding these items.

Discussion of the Findings

The information in Table 1b provided the answer to research question one. Findings revealed that no item falls under none, very low, and low values. Equally, items 4, 1 and 15 fall under moderate, high, and very high values respectively. This implies that the BECE 2019 a-parameter is adequate. This is in line with the findings of Ibrahim (2018) who reported that 52 out of the 60 items in the 2016 Mathematics BECE in Gombe state, Nigeria discriminated well between the high and low-ability groups of students that took the test.

Table 2b provided the answer to research question two. The findings revealed that 5 items are difficult while 15 items are easy. This is similar to the findings from the work of Alfanda (2019). Her findings revealed 57 out of the 70 items in the examination are easy items, with only 13 items found to be difficult.

However, table 3b portrays the answer to research question three. The outcome from the analysis indicated that 5 out of the 20 items have very low guessing values and 15 items have high values. These findings are in line with the findings of Ibrahim (2018) where the findings show that the majority of the items display a high probability of guessing.

Table 4b provides the answers to research question four. The findings show that none of the items fall under none and are very low. However, item 2 falls under low value. Moreover, items 4 and 10 are high and very high values respectively. This infers that the majority of the items in the BECE 2021 a-parameter are adequate. These findings are consistent with the findings earlier made by Obarasua and Orluwene (2022) which stated that all the test items in their study passed the psychometric properties criteria.

The answer to research question five is in Table 5b. It can be understood from the findings that a minority of the items (7) are difficult while the majority (13) are difficult. Similar findings were made by Toyin (2015) where the study shows a high proportion of the test items have an appropriate difficulty index.

Moreover, table 6b reveals answers to research question six. The findings from the analysis indicated that 5 out of the 20 items have very low guessing values while 15 items fall under the high category. By implication, the chance of getting an answer correctly by mere guessing is high regarding these items.

Conclusion

Based on the findings of the study, it was concluded that the 2019 BECE Mathematics objective test items had adequate discrimination and difficulty indices. The test also showed that the majority of the items had passed the distracter indices criteria. In the same vein, the 2021 BECE Mathematics also showed that both discrimination and difficulty indices were adequate. The findings however shows that the majority of the item passed the distracter indices criteria.

Recommendations

The recommendations for this study are as follows:

1. Government and private school proprietors should endeavour to sponsor teachers, especially in the examination offices to attend conferences, workshops, and seminars to be up-to-date on how to generate test items that meet item analysis and test criteria.
2. Ministry of basic education should ensure proper supervision of schools to be sure that teachers abide by rules governing test construction, administration, and reporting.
3. BECE items need to be pilot tested before actual administration to be sure that only items that meet the criteria can be retained. Items that fail should be either modify or discarded.

References

Alfanda, Z. A. (2019). *Item analysis of the 2014 English language senior Arabic and Islamic secondary school certificate examination (SAISSCE) in Kano municipal education zone, Kano state, Nigeria.* Unpublished M.Ed Dissertation, Bayero University, Kano

Anaman, P.D., Zottor, D.M. and Egyir, J.K. (2022). Infrastructural Challenges and Student Academic Performance: Evidence from a Developing Nation. *International Journal of Innovative Science and Research Technology*. https://www.researchgate.net/publication/366289463

Ani, E. N. (2014). *Application of Item Response Theory in the development and validation of multiple choice test in Economics*. M.Ed thesis, University of Nigeria, Nsukka.

Anikweze, V.M. (2012). *Measurement and Evaluation for Teacher Education*. 3rd Edition Malijoe Soft Print.

Ayanwale, M. A., Adeleke, J. O.& Mamadelo, T. I. (2018). An Assessment of Item Statistics Estimates of Basic Education Certificate Examination through Classical Test Theory and Item Response Theory Approach. *International Journal of Educational Research Review.* https://www.ijere.com 55

Baker, F.B. (2001). *The Basics of Item Response Theory*. U.S.A; ERIC Cleaning House on Assessment and Evaluation.

Bashir, A., Bashir, S., Rana, K., Lambert, P, & Vernallis, A. (2021). Post-COVID-19 Adaptations; the Shifts Towards Online Learning, Hybrid Course Delivery and the Implications for Biosciences Courses in the Higher Education Setting. https://doi.org/10.3389/Leduc .2021.711619

Bassey, A.U., Jacob, E.S & Nobel, C. N. (2022). Guessing Parameters and Multiple-Choice Test Items of 2016 - 2017 National Examination Council (NECO) Mathematics Examination Instruments in Calabar Education Zone of Cross River State. *Journal of Advances in Education and Philosophy*. https://doi.org/10.36348/jaep.2022.v06i09.007

Bond, T. G., & Fox, C. M. (2007). *Applying the Rasch model: Fundamental Measurement in the Human Sciences* (2nd. ed.). Mahwah: Erlbaum.

DeMars, C. (2010). *Item Response Theory, Understanding Statistics Measurements.* Oxford Publishers.

Edelen, M. O. & Reeve, B. R. (2007). Applying item response theory (IRT) Modelling to Questionnaire Development, Evaluation, and Refinement. *Qual Life Res*, 16, 5.

Embretson, S. E. & Reise, S. P. (2000). *Item response theory for psychologists.* Erlbaum: Mahwah.

Hambleton, R.K. (1994). Guidelines for Adapting Educational and Psychological Tests: A Progress Report. *European Journal of Psychological Assessment (Bulletin of the International Test Commission).* https://doi.org/10.4236/jss.2016.44022

Hambleton, R.K. & Swaminathan, H. (1985). Item response theory: Principles and Applications. *Australian Journal of Basic and Applied Sciences, 9(7) April 2015*, Pg: 549-556. ISSN:1991-8178. Retrieved from www.ajbasweb.com

Hussaini, A. (2023). *Item Analysis of Mathematics 2018 Basic Education Certificate Examinations in Sokoto state, Nigeria*. An unpublished dissertation. Bayero University, Kano.

Hussaini A. and Bello, S. (2023). Lecturers' Perception Towards Blended Learning in the Post Covid-19 Era in Tertiary Institutions in Sokoto State, Nigeria. *International Council for Education, Research and Training (ICERT)*. www.icert.org.in. ISBN: 978-93-95789-05-9

Ibrahim, A. (2018). *Psychometric Analysis of 2016 Mathematics Basic Education Certification Examination in Gombe State*. Unpublished M.Ed Dissertation. Bayero University, Kano.

Kofi, S. (2020). What will Higher Education in Afrika Look Like after Covid-19? https://www.weforum.org/agenda/2020/06/higher-education-africa-covid19-coronavirus-digital-online/

Krishnan, V. (2013). *The Early Child Development Instruments (EDI): An Item Analysis using Classical Test Theory (CTT) on Alberta"s Data.* Early Child Development Mapping (ECMap) Project Alberta, Community- University Partnership (CUP), Faculty of Extension, University of Alberta, Edmonton, Alberta.

Magis, D. (2007). Influence, Information, and Item Response Theory in Discrete Data Analysis. https://www.bictel.ulg.ac.be/ETD db/collection/available/ULgetd 06122007-100147/

Ministry for Basic and Secondary Education, Sokoto (2019).

Morizot, J., Ainsworth, A. T., & Reise, S. P. (2007). *Toward modern psychometrics: Application of item response theory models in personality research*. R. W. Robins.

Obarasua, B.L., and Orluwene, G.W. (2022). Psychometric Analysis of 2018-2020 Basic Education Certificate Examination Mathematics Objective Test Items. *East African Scholars Journal of Psychology and Behavioural Sciences.* EASJ PsycholBehavSci https://doi.org/10.36349/easjpbs.2022.v04i01.005

Ogunbanwo, R. A. (2014). *Analysis of students' performance in West African senior certificate examinations in boarding and day secondary schools in Kano metropolis, Nigeria (2005-2011)*. Unpublished M.Ed. The project, Ahmadu Bello University, Zaria, Nigeria.

Ohanyelu, C.N. (2021). Augmentation of Students' Academic Performance in Mathematics Through Classroom Management Practices in Nigeria. *Turība University Conference - Artificial Intelligence and Green Thinking.* https://www.researchgate.net/publication/352983359

Salkind, N. J. (Ed.). (2010) Encyclopedia of Research Design. SAGE Publications, Inc. https://doi.org/10.4135/9781412961288

Toyin, D. M. (2015). Analyzing the Psychometric Properties of Mathematics in Public Examinations in Nigeria, *Research on Humanities and Social Sciences.* https://www.iiste.org ISSN: 2225-0484, Vol.5, No.7

Warm, T. A. (1978). *A primer of item response theory*. National Technical Information Services Department of Commerce, Oklahoma City, OK: U.S. Coast Guard Institute.