Greener Journal of Educational Research
Vol. 15(1), pp. 60-70, 2025
ISSN: 2276-7789

https://gjournals.org/GJER
DOI: https://doi.org/10.15580/GJER.2025.1.042525075

An Item Response Theory (IRT) Based Assessment of Psychometric Properties of Basic Science and Technology Basic Education Certificate Examination in Borno State, Nigeria.

Emmanuel Daniel Kaigama[1]; Saurayi I. Dadughun[2]; Abbas Y. Mustapha[3]

Department of Educational Foundations,
Faculty of Education University of Jos, Nigeria.

ARTICLE'S INFO

Article No.: *042525075*
Type**:** *Research*
Full Text: *PDF, PHP, EPUB, MP3*
DOI: *10.15580/GJER.2025.1.042525075*

Accepted: *26/04/2025*
Published: *04/05/2025*

Keywords: *Item Response Theory (IRT), psychometric, BST, test, item Difficulty, item Discrimination, pseudo-guessing*

Corresponding Author

Emmanuel Daniel Kaigama

E-mail: *emmanuel.kaigama@funai.edu.ng*

Article's QR code

ABSTRACT

The study examined the psychometric properties of 2021/2022 Basic Science and Technology (BST) items in the Basic Education Certificate Examination (BECE) administered in Borno State, Nigeria. The study was carried out against the backdrop of persistent underperformance in Senior School Certificate Examination (SSCE) science subjects. A descriptive survey design was employed, using probability proportion to size sampling technique to sample 3557 students script out of 51946 scripts of students that sat for the 2021/2022 Basic Education Certificate Examination Basic Science and Technology in Borno State, Nigeria. A document consists of question paper and students' scripts was adopted from Borno State Education board as an instrument for data collection. The students' responses on each item on the script were analyzed using X-Calibre 4.2 three-parameter Item Response Theory (IRT) model to estimate item difficulty, discrimination and pseudo-guessing indices. Results indicated that a majority of both multiple-choice and essay items were classified as easy, 14 multiple-choice items and 3 essays were moderately difficult; and fewer items fell into the difficult and very difficult categories. Item discrimination analysis revealed that 57.5% of multiple-choice items and all essay questions effectively distinguished between high and low ability examinees (a-value > 0.50), whereas 42.5% of objective items lacked adequate discriminatory power. The pseudo-guessing parameter showed that 88.8% of items minimized correct responses attributable to guessing, underscoring generally robust item construction. However, the presence of overly simplistic questions and a subset of weakly discriminating items signals room for refinement. It is therefore, concluded that BECE BST items for 2021/2022 in Borno State satisfy fundamental psychometric standards for difficulty, discrimination and guessing parameter, but they also highlight specific areas particularly item difficulty balance and discrimination consistency where enhancements are warranted. To address these gaps, the following recommendations were made: federal ministry of education through state education board should in force a compulsory course on development and standardization of test for all those personnel constructing test for BECE BST at state and national level. Such capacity building will strengthen the alignment between BST assessments and the competencies required for success in senior secondary science curricula, thereby improving student placement accuracy and mitigating long-term shortages of qualified science professionals in medicine, engineering, agriculture and education.

INTRODUCTION

Basic Science and Technology (BST) is a foundational subject that prepares students for more specialised scientific subjects like biology, chemistry and physics at senior secondary school and higher education levels. Science plays a vital role in the lives of individuals and the development of a nation scientifically and technologically by making life better, easier and more comfortable; providing ideas that make work faster; passing information easily with speed and accuracy and facilitating the easy transportation of goods from one place to another within a short time. The Federal Government of Nigeria (FGN), being conscious of the importance of science and science literacy in the survival of the citizenry and the nation at large, stated that the education system shall emphasise science at all levels.

The critical role of science in nation-building led the FGN to introduce the study of science at all levels of education, starting from the basic education level to the higher education level. This is to enable the citizenry to acquire the necessary science literacy for the advancement of the country. Basic Science and Technology as a subject was purposely provided as part of the effort to harmonise the study of science at the basic education level. The four subjects, such as basic science, basic technology, information and technology and physical and health education were integrated to be called Basic Science and Technology. The thematic integration of these subjects is to strategize teaching science subjects at the basic education level as the fundamental unity of scientific thought.

With the integration, it is assumed that for a student to study a single science subject and do well in it at the senior secondary school level, such a student must learn BST well at the basic education level, as the success in it serves as qualification for studying science subjects at senior secondary schools. This explains the emphasis given to Basic Science and Technology in the basic education curriculum. The premium placed on

science subjects strengthens their usefulness in the lives of the citizenry. Sunday (2021) noted that Basic Science and Technology at the basic education level provides a child with science literacy to acquire appropriate skills, abilities and competencies to contribute meaningfully to the development of the country. The Basic Science and Technology curriculum is a broad field curriculum in which subjects matter is integrated with the various science subjects studied at senior secondary school (Biology, Physics & Chemistry) to provide students with a holistic and unified nature of science.

The curriculum components of BST studied at the basic education level and the curriculum of Biology, Chemistry and Physics studied at the senior secondary school level have some common similarities. For instance, in basic I, topics such as nutrition, balanced diet, population and living and non-living things are topics in Senior Secondary I (SSI) Biology. In basic II Basic Science and Technology, topics such as energy, chemicals, force, friction and gravity are found in Chemistry and Physics in SS I and Senior Secondary II (SS II). More so, topics like reflection and fraction of waves, electron flow and radioactivity are the topics that are taught in basic III and also taught in physics and chemistry in senior secondary school II and III. The similarity of curriculum contents between BST and core science subjects led to the policy of using BST in the Basic Education Certificate Examination (BECE) as a prerequisite subject for the promotion of students from basic education into science classes at senior secondary school.

The Basic Education Certificate Examination is a core examination made compulsory for all Nigerian students at the end of their upper basic education level. The examination is conducted by the state education board under the supervision of the National Examination Council (NECO) for the promotion of students who are to transit from basic education to senior secondary school. The placement of students into science, art, commercial and vocational classes at Senior Secondary School is based on their performance in BECE results. Those students who did well in mathematics and BST are promoted to science classes. Those who did well in the English language, civic education, social studies, creative arts and business studies are promoted to other classes based on their performance in the subjects (UBE, 2014).

Despite the relative importance of science to the country's quest for technological advancement, it is observed that students' performance in BST does not predict students' performance in SSCE core science subjects (Biology, Chemistry & Physics). Evidence contained in the research reports by Joseph (2023) revealed that the performance of students who sat for BECE BST in the 2018/2019 academic session was better than their later performance in the SSCE 2021 academic session. Statistics from the Borno State Education Resource Centre (2024) show that 63% of the students' who sat for BECE BST in the 2018/2019 academic session passed the BST, but the percentage of the same students who passed Biology, Chemistry and Physics in SSCE 2021 was 47%. More so, 88% of the students passed the BECE BST 2020/2021 academic session; only 49% of those students passed SSCE core science subjects after their promotion into senior secondary schools. The low ability of BECE to predict students' performance in science in SSCE highlights the need for the closer examination of the BECE BST effectiveness in predicting students' performance in senior secondary school and addressing potential gaps in curriculum alignment and assessment methods. The effectiveness of the test item can only be assessing through establishing psychometric properties of a test.

Psychometric properties refer to the characteristics of a test that measure its quality and effectiveness in assessing students' knowledge and skills. These properties include discrimination, difficulty and guessing parameters. Psychometric properties refer to a procedure that provides a test developer with the opportunity to examine both test items and the answers supplied by the testees to find out whether they are of adequate quality and if the content coverage is sufficient for the test they are developed for. Psychometric properties are assessed on a test after it has been administered. The analysis of psychometric properties of a test allows for the observation of item characteristics and the improvement of the quality of the test. Psychometric properties help the test developer to examine each specific item to appraise its quality concerning discrimination, difficulty and guessing parameters. The discrimination parameter (*a*) tells about the quality of an item in identifying examinees with high and lower ability. Failure of the test developer to check the quality of the item in discriminating students according to their ability, the items may end up misleading and giving faulty information about examinees ability.

The discrimination parameter has a curve slope inversely related to the distance one must travel along the ability continuum. The steeper the slope of the item characteristic curve, the greater the discrimination of the item between the high-ability and low-ability groups. Indeed, with a high a-value, the item has a steep characteristic curve and discriminates well (Brochu, 2016). Therefore, the higher the discrimination value, the better the item can separate examinees into different levels of ability in the region of item difficulty. Items that are unable to separate examinees into ability levels should be discarded, as they are not good items and provide no useful information on the testees of different ability scales.

The difficulty parameter is a location index that indicates the position of the item functions on the ability scale, showing how difficult or easy a specific item is. The typical values of the item difficulty range from -3 to +3; items whose difficulty value are near -3 will correspond to items that are very easy, while items with values near +3 will correspond to the items that are very difficult for the examinees. The guessing parameter (*c*) represents the probability that a correct response occurs by chance.

The parameter takes care of item response data from low-ability examinees. The guessing parameter guarantees the quality of the item in checkmating the probability of the examinee who passed the examination solely by guessing. The parameter has a theoretical range of $0 \leq c \leq 1.0$, but in practice, values above 0.25 are not considered acceptable.

There are two measurement frameworks that guide the analysis of the psychometric properties of tests: classical test theory (CTT) and item response theory (IRT). CTT represents traditional testing and serves as the foundation for IRT. CTT deals with the reliabilities of relative decisions, where an individual's score is compared with a reference group and used for ranking the individual as a norm-referenced measurement. IRT measures the inherent ability that produces test performance rather than measuring actual test performance. Therefore, for the purpose of this study, the IRT framework was adopted to guide the study in assessing the psychometric properties of BECE BST in Borno State, Nigeria.

Statement of the Problem

The Basic Education Certificate examination in Nigeria is a core examination made compulsory for all Nigerian students at the end of their upper basic education to assess the academic performance of students and promote them to senior secondary school classes where they fit in based on their performance in the BECE result. Those students who did well in mathematics and BST are promoted to science classes to study core science subjects and those who performed well in English, social studies, civic education, creative arts and business studies are promoted to other classes like art, commercial and vocational based on their performance in the subjects.

The extent to which the BECE predicts students that would perform well in senior secondary school is not certain. Available statistics from the Borno State Ministry of Education show that students are performing well in BECE BST, but they fail to replicate the same performance in SSCE in science-related subjects. For example, the statistics showed that the students who passed BECE BST in 2019 were 63%, but the same students are the ones who were reported to have performed poorly in SSCE 2021, with only 47% of students who got credit in science subjects in Borno State. More so, in 2021, 88% of students who passed BECE BST are the same students that reported performing poorly in SSCE 2023, with only 49% of students who got credit in science subjects in Borno State.

These state of discrepancies may be as a result of gaps in knowledge of students' in their Basic Science and Technology earlier graded, failure of curriculum to prepare students for the complexities of senior secondary science subjects, assessment methods, teachers quality and limited resources to teach BST, like textbooks and laboratory equipment. Efforts have been made by the state government to address the trend of poor performance through the employment of science teachers, training and retraining of teachers, provision of textbooks, instructional materials and laboratory equipment for teaching science subjects, but still the performance remained poor.

The consequence of continued poor performance is that the students after their senior secondary schools will not be able to get admission into higher education to read science-related courses, which will later result in a shortage of manpower in the fields that are science-based, like medicine, agriculture, engineering, architecture and even teachers who can teach BST and other related science subjects in the near future. However, there have been ongoing debates regarding the psychometric properties of BECE, particularly in relation to its validity, reliability and its effectiveness to measure students' ability. This therefore calls for the need to assess the psychometric properties of the BECE BST examination questions to ascertain the quality of the test items used in Borno State to promote students into science classes. Since the researcher is not aware of any current effort aimed at establishing the psychometric properties of BECE BST in the study area. Hence, there is a need for this study so as to fill the gap. Therefore, the problem of this study can be subsumed under the broad question: What are the psychometric properties of BECE Basic Science and Technology test items in Borno State, Nigeria?

Objectives of the Study

The aim of the study is to assess the psychometric properties of the Basic Science and Technology Basic Education Certificate Examination in Borno State, Nigeria. Specifically, the objectives of this study are to:

1. determine the difficulty parameters of BECE BST test items for 2021/2022 in Borno State, Nigeria.
2. assess the discrimination parameters of BECE BST test items for 2021/2022 in Borno State, Nigeria.
3. assess the guessing parameters of the BECE test items for 2021/2022 BST in Borno State, Nigeria.

Research Questions

The following research questions have been raised to guide the study.

1. What are the item difficulty parameters for 2021/2022 BECE BST items in Borno State, Nigeria?
2. What are the item discrimination parameters of 2021/2022 BECE BST items in Borno State, Nigeria?

3. What are the guessing parameter indices of the 2021/2022 BECE BST items in Borno State, Nigeria?

Significance of the Study

It is hoped that the findings of this study will benefit the following: students, teachers, school administrators, researchers, the Borno State Universal Basic Education Board, curriculum developers, the Borno State Government and the Ministry of Education. The result of this study, when it is completed and published, will benefit students to serve as their media to communicate with the state education board on the state of the quality of BECE test items used to assess students and need to develop fair and unbiased test items that all students, regardless of background, will have an equal chance to pass. This will make BECE more inclusive and less likely to disadvantage certain groups of students. The study will also benefit students when it is completed to encourage test developers to develop reliable test items so that their scores will reflect their true abilities. This will boost the credibility of giving student feedback that is a true representative of student academic strength and areas for improvement.

The literature from this study, when it is completed, will help teachers develop a deeper understanding of educational assessment, which can enhance their professional skill in test development in their careers. The findings of this study will also provide teachers with information on the extent to which they will rely on students' performance in BECE in predicting how students' will perform in senior secondary school after the completion of this research work and published. This study will be beneficial to school administrators in Borno State because it will expose to them the quality of test items they have been using to promote students into senior school after the completion and publication of this study.

This study will benefit researchers because, when it is completed and published, the researcher that will lay hands on this work will use it as a reference material for further studies in the area of psychometric properties of tests. The Borno State Universal Basic Education Board will benefit from this study when it is completed; it will inform them about the quality of BECE BST items they used to assess the students for placement into senior secondary school classes. More so, the Borno State Universal Basic Education Board will use the results of this study, when it is completed and published as literature, for the training of their personnel who are constructing items for BECE as a guide to help them construct items of good quality for placement of students into senior secondary school classes.

The finding of this study after completion will provide curriculum planners with insight on the state of quality of the instrument that was constructed by state education boards to assess students' knowledge and skill for promotion into senior secondary school. This can guide adjustment in curriculum design to ensure it aligns with the assessment objectives. The finding will also provide curriculum planners with valuable information that will help them enhance the assessment process, leading to more effective and better student' outcomes. The results of this study when it is completed and published, will serve as reference material for further research in the area of item analysis and differential item functioning. The study will provide information to the Ministry of Education when it is completed and published to increase their efforts to harmonise the implementation strategies for assessment, particularly in ensuring the quality of instruments used by State Education Boards in BECE for the promotion of students to senior secondary school.

Theoretical Framework

The study was guided by the Item Response Theory (IRT) propounded by Lord and Novick (1968). This is because IRT considers the characteristics of each item outside the total score, so that the conclusion made on each item will not depend on the entire test but on each item that comprises the entire test. IRT refers to a family of latent trait models used to establish the psychometric properties of a test. The model describes the relationship between a person's standing trait and his or her standing underlying construct. Nweke (2021) asserted that the IRT model explains relationships among observed variables in terms of one or more unobserved variables, which are referred to as traits, while the developmental level score is the latent trait score, which is a special kind of factor score. Item Response Theory is a pivotal framework in educational assessment, enabling the meticulous evaluation of individual test item performance across diverse populations. This sophisticated approach goes beyond traditional scoring, delving into how specific item characteristics like difficulty and discrimination interact with examinees abilities to predict response patterns accurately (Ainsworth, 2016).

The principles that guide the basis of using IRT in establishing the psychometric properties of test items are difficulty, discrimination and guessing. These principles form the foundation for evaluating the quality of test items to measure the ability of testees. Difficulty parameter provides the basis to identify items that are difficult and easy. Discrimination parameter identifies the test items that differentiate students based on their ability and those items that cannot discriminate examinees based on their ability. Whereas, the guessing parameter identifies the test item that were answered correctly by chance by examinees with low ability. Therefore, the adoption of IRT as a theoretical framework for this study is appropriate since the study aimed to establish the psychometric properties of BECE BST test items that were used in Borno State for the 2021/2022 academic session for promoting students into science classes at senior secondary school.

Scope of the Study

The study focused on assessing the psychometric properties of the 2021/2022 BST test items for BECE in Borno State, Nigeria. The study adopted IRT analysis and restricted its scope to the assessment of 1PLM, 2PLM and 3PLM of multiple-choice test items and 1PLM and 2PLM of essay questions. This is because the models report the extent to which the items are of good quality to discriminate against students based on their ability in a particular test. The 4PLM, which accounted for factors influencing item performance in a test, was not assessed because the parameter it measured was not part of the study's objectives.

METHODOLOGY

This was conducted using a survey research design. Because Survey research is a form of research design used when dealing with the systematic collection of data or information from a sample of the population to draw inferences about a particular phenomenon. The population of the study consisted of 51,948 scripts of students who sat for the BECE Basic Science and Technology (BST) in the 2021/2022 academic session within the 388 Public Junior Secondary Schools in 27 Local Government Areas (LGAs) in Borno State. A multi-stage sampling procedure was adopted in this study to ensure adequate representation of educational zones, local government areas (LGAs) and schools in Borno State. The instrument for data collection was documents consisting of student scripts and question papers for BST BECE for the 2021/2022 academic session in Borno State. The document consisted of question papers and scripts for BST BECE was adopted from the Universal Basic Education Board in Borno State. The question paper had two sections, namely: Section A and Section B. Section A consisted of 80 objective items with four options for Basic Technology and three options for Basic Science items. The items for Basic Technology were labelled alphabetically from A to D while the Basic Science items were labelled from A to C. Section B comprised essay questions consisting of 10 questions. The examinees were required to respond to only six (6) questions from Section B. The scripts were booklets that contained the students' responses to the items on the question paper. Each booklet consisted of two answer papers. Answer paper 2 appeared first in the booklet followed by paper 1. The objective test answer sheet contained four options for Basic Technology and three options for Basic Science, labelled alphabetically from A to D for Basic Technology and A to C for Basic Science. Data were analyzed using maximum likelihood chi-square of X-Calibre version 4.2 to assess the 3-parameters of IRT model (difficulty, Discrimination & guessing parameter).

Answer to Research questions

Research Question One: What are the item difficulty parameters for 2021/2022 BECE BST items in Borno State, Nigeria?

Table 1. Item Difficulty Parameters for 2021/2022 BECE BST Test Items

Item ID	Difficulty	Remark	Item ID	Difficulty	Remark	Item ID	Difficulty	Remark
1	0.72	Easy	31	0.16	V/Difficult	61	0.66	Easy
2	0.94	Easy	32	0.72	Easy	62	0.12	Difficult
3	0.82	Easy	33	0.8	Easy	63	0.22	Difficult
4	0.7	Easy	34	0.82	Easy	64	0.7	Easy
5	0.84	Easy	35	0.92	Easy	65	0.3	Moderate
6	0.38	Moderate	36	0.62	Easy	66	0.44	Moderate
7	0.02	V/difficult	37	0.76	Easy	67	0.64	Easy
8	0.42	Moderate	38	0.64	Easy	68	0.76	Easy
9	0.72	Easy	39	0.32	Moderate	69	0.24	Difficult
10	0.7	Easy	40	0.88	Easy	70	0.2	Difficult
11	0.66	Easy	41	0.98	Easy	71	0.8	Easy
12	0.72	Easy	42	0.86	Easy	72	0.8	Easy
13	0.78	Easy	43	0.98	Easy	73	0.08	Difficult
14	0.26	Difficult	44	0.86	Easy	74	0.06	Difficult
15	0.8	Easy	45	0.66	Easy	75	0.06	Difficult
16	0.84	Easy	46	0.58	Moderate	76	0.04	V/difficult
17	0.48	Moderate	47	0.06	V/difficult	77	0.56	Moderate
18	0.72	Easy	48	0.62	Easy	78	0.7	Easy
19	0.8	Easy	49	0.1	V/Difficult	79	0.02	V/difficult
20	0.2	V/Difficult	50	0.4	V/Difficult	80	0.44	Moderate
21	0.56	Moderate	51	0.26	Difficult	Es1	0.18	Difficult
22	0.12	V/Difficult	52	0.36	Moderate	Es2	0.38	Moderate
23	0.86	Easy	53	0.24	Difficult	Es3	0.70	Easy
24	0.58	Moderate	54	0.72	Easy	Es4	0.66	Easy
25	0.22	V/Difficult	55	0.98	Easy	Es5	0.76	Easy
26	0.42	Moderate	56	0.86	Easy	Es6	0.22	Difficult
27	0.34	Moderate	57	0.5	Difficult	Es7	0.42	Moderate
28	0.8	Easy	58	0.28	Difficult	Es8	0.60	Easy
29	0.82	Easy	59	0.22	Difficult	Es9	0.56	Moderate
30	0.74	Easy	60	0.04	V/difficult	E10	0.74	Easy

Easy item: 0.60 - 1.0; Moderate item: 0.30 – 0.59; Difficult item: 0.5 - 0.29; very difficult: 0.01 – 0.04
Note: n = 3557.

Table 1 above indicated that 14 items (6, 8, 17, 21, 24, 26, 27, 39, 46, 52, 65, 66, 77 & 80), representing 17.5% of the 80 multiple-choice items and three essay items (2, 7 & 9) were within the acceptable difficulty level of 0.30 - 0.59 (moderate). Thirteen items (14, 51, 53, 57, 58, 59, 62, 63, 69, 70, 73, 74 and 75), representing 16.3% of the 80 multiple-choice items and two essay items (1 & 6) were classified as difficult, fell within the difficult range of 0.1 - 0.29. Eleven items (7, 20, 22, 25, 31, 47, 49, 50, 60, 76 & 79), representing 13.7% of the multiple-choice items, were very difficult, fell within the most difficult item range of 0.01 – 0.09. Whereas, 42 multiple-choice items (1, 2, 3, 4, 5, 9, 10, 11, 12, 13, 15, 16, 18, 19, 23, 28, 29, 30, 32, 33, 34, 35, 36, 37, 38, 40, 41, 42, 43, 44, 45, 48, 54, 55, 56, 61, 64, 67, 68, 71, 72 & 78), representing 52.5% of the 80 items, and five essay items (3, 4, 5, 8 & 10) were classified as easy (0.60 – 1.0). This implied that most of the BECE BST multiple-choice and essay items for 2021/2022 were easy for secondary school students in Borno State, Nigeria.

Research Question Two: What are the item discrimination parameters of 2021/2022 BECE BST items in Borno State, Nigeria?

Table 2. Item Discrimination Parameters for 2021/2022 BECE BST Test Items

Item ID	*a* Parameter	Remark	Item ID	*a* Parameter	Remark	Item ID	*a* Parameter	Remark
1	0.50	D/well	31	-0.15	Not D/well	61	0.68	D/well
2	0.03	Not D/well	32	0.46	D/well	62	-0.10	Not D/well
3	0.32	D/well	33	0.21	D/well	63	-0.46	Not D/well
4	0.50	D/well	34	0.66	D/well	64	0.00	Not D/well
5	0.32	D/well	35	0.54	D/well	65	0.00	Not D/well
6	-0.10	Not D/well	36	0.55	D/well	66	0.66	D/well
7	-0.06	Not D/well	37	0.18	D/well	67	0.75	D/well
8	-0.02	Not D/well	38	0.03	Not D/well	68	0.43	D/well
9	0.30	D/well	39	-0.44	Not D/well	69	-0.43	Not D/well
10	0.42	D/well	40	0.58	D/well	70	0.00	Not D/well
11	0.68	D/well	41	0.44	D/well	71	0.48	D/well
12	0.12	D/well	42	0.62	D/well	72	0.29	D/well
13	0.35	D/well	43	0.44	D/well	73	-0.05	Not D/well
14	-0.42	Not D/well	44	0.62	D/well	74	0.20	D/well
15	0.15	D/well	45	0.72	D/well	75	0.03	Not D/well
16	0.47	D/well	46	0.58	D/well	76	0.03	Not D/well
17	0.28	D/well	47	-0.11	Not D/well	77	0.47	D/well
18	0.35	D/well	48	0.50	D/well	78	-0.09	Not D/well
19	0.14	D/well	49	-0.07	Not D/well	79	0.09	Not D/well
20	-0.21	Not D/well	50	-0.65	Not D/well	80	0.20	D/well
21	0.22	D/well	51	0.10	D/well	Es1	1.14	D/well
22	-0.10	Not D/well	52	-0.55	Not D/well	Es2	1.14	D/well
23	0.21	D/well	53	-0.26	Not D/well	Es3	0.63	D/well
24	0.44	D/well	54	0.54	D/well	Es4	0.48	D/well
25	-0.34	Not D/well	55	0.34	D/well	Es5	0.46	D/well
26	-0.05	Not D/well	56	0.70	D/well	Es6	0.57	D/well
27	-0.49	Not D/well	57	0.62	D/well	Es7	0.50	D/well
28	0.43	D/well	58	-0.07	Not D/well	Es8	0.35	D/well
29	0.02	Not D/well	59	-0.04	Not D/well	Es9	0.47	D/well
30	0.46	D/well	60	0.07	Not D/well	E10	0.42	D/well

Item < 0.50 not discriminating well (Not D/well); Item > 0.50 discriminating well (D/well)
Note: n = 3557.

Table 2 above revealed that 34 items, representing 42.5% of the 80 multiple-choice items (2, 6, 7, 8, 14, 20, 22, 25, 26, 27, 29, 31, 38, 39, 47, 49, 50, 52, 53, 58, 59, 60, 62, 63, 64, 65, 69, 70, 73, 75, 76, 78 & 79), did not discriminate well because their a-values were less than 0.5, which served as the yardstick for determining items that could not effectively differentiate examinees based on their ability. Items with negative signs indicated that they were very poor and even confused high-ability students, preventing them from selecting the correct key (answer). On the other hand, 46 items, representing 57.5% of the multiple-choice items (1, 3, 4, 5, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 21, 23, 24, 28, 30, 32, 33, 34, 35, 36, 37, 40, 41, 42, 43, 44, 45, 46, 48, 51, 54, 55, 56, 57, 61, 66, 67, 68, 71, 72, 77 & 80) and all 10 essay items discriminated well, as they had a-values greater than 0.5. This implied that the majority of the BECE BST items for the 2021/2022 academic session effectively discriminated among students based on their ability, given that the number of items with a-values greater than 0.5 exceeded those with a-values below 0.5.

Research Question Three: What are the guessing parameter indices of the 2021/2022 BECE BST items in Borno State, Nigeria?

Table 3: Guessing Parameters Indices of 2021/2022 BECE BST Test Items

Item ID	Guessing parameter	Remark	Item ID	Guessing parameter	Remark
1	0.23	Not prone	41	0.25	Not prone
2	0.24	Not prone	42	0.25	Not prone
3	0.36	Prone	43	0.25	Not prone
4	0.25	Not prone	44	0.25	Not prone
5	0.25	Not prone	45	0.24	Not prone
6	0.26	prone	46	0.24	Not prone
7	0.22	Not prone	47	0.22	Not prone
8	0.25	Not prone	48	0.25	Not prone
9	0.25	Not prone	49	0.23	Not prone
10	0.25	Not prone	50	0.27	Prone
11	0.25	Not prone	51	0.22	Not prone
12	0.25	Not prone	52	0.25	Not prone
13	0.25	Not prone	53	0.33	Prone
14	0.25	Not prone	54	0.25	Not prone
15	0.25	Not prone	55	0.25	Not prone
16	0.25	Not prone	56	0.25	Not prone
17	0.25	Not prone	57	0.24	Not prone
18	0.25	Not prone	58	0.25	Not prone
19	0.25	Not prone	59	0.24	Not prone
20	0.24	Not prone	60	0.22	Not prone
21	0.25	Not prone	61	0.25	Not prone
22	0.23	Not prone	62	0.23	Not prone
23	0.25	Not prone	63	0.24	Not prone
24	0.25	Not prone	64	0.26	Prone
25	0.24	Not prone	65	0.25	Not prone
26	0.26	Prone	66	0.24	Not prone
27	0.26	Prone	67	0.24	Not prone
28	0.25	Not prone	68	0.25	Not prone
29	0.25	Not prone	69	0.25	Not prone
30	0.25	Not prone	70	0.24	Not prone
31	0.24	Not prone	71	0.25	Not prone
32	0.25	Not prone	72	0.25	Not prone
33	0.25	Not prone	73	0.22	Not prone
34	0.25	Not prone	74	0.22	Not prone
35	0.25	Not prone	75	0.22	Not prone
36	0.25	Not prone	76	0.22	Not prone
37	0.25	Not prone	77	0.25	Not prone
38	0.25	Not prone	78	0.26	Prone
39	0.26	Prone	79	0.22	Not prone
40	0.25	Not prone	80	0.25	Not prone

Item value < 0.25 not prone to guessing; item value > 0.25 prone to guessing
Note: n = 3557.

Table 3 above indicated that 71 of the 80 items representing 88.8% were not prone to guessing. Whereas 9 items (3, 6, 26, 27, 39, 50, 53, 64 & 78), which represented 11.2%, were prone to guessing. This implied that most of the 2021/2022 BECE BST items checkmated guessing among the students who sat for the BECE BST in the 2021/2022 academic session.

RESULTS

The summary of findings was:

1. The results revealed that 42 multiple-choice items and 5 essay items for 2021/2022 were easy, 14 multiple choice items and 3 (30%) essay items were moderately difficult, 13 multiple-choice items and 2 essay items were difficult, whereas 11 multiple choice items were very difficult.
2. The results revealed that 57.5% of multiple-choice items and all essay items for 2021/2022 discriminated between high and low-ability students (a-value > 0.5), whereas 42.5% of multiple-choice

items were not able to discriminate students according to their ability.

3. The pseudo-guessing analysis of BECE BST items showed that most items were not prone to guessing. Eighty-eight point eight percent (88.8%) of the items effectively minimized guessing, while 11.2% were prone to guessing.

DISCUSSION OF FINDINGS

The results of the findings for research question one revealed that majority (52.5%) of the BECE BST multiple-choice and half (50%) of the essay items in Borno State were easy items, only 45.5% of the multiple choice items and 50% of essay items fell within the range of moderate and difficult item. This finding were in agreement with the finding of Soloman, Emaiku and Obinne (2020), who reported that the majority of BECE BST items in Markudi were outside the acceptable range. On the other hand, the findings were contrary to the finding of Obarasua and Orluwane (2022), who reported a high reliability coefficient for BECE BST items for 2018 in River State. This implies that the items of BECE BST for 2021/2022 in Borno State were easy to students which could be the reason of the failure of students that were promoted to science classes at senior secondary school to replicate the same performance they had in BST at senior classes in science related subjects.

The results from research question two revealed that the majority (57.5%) of the test items of exhibited strong discrimination, indicating that they effectively measured differences in student ability with only a few items having low discrimination indices. This finding were in agreement with the finding of Obi and Osarumwense (2019), who reported that the majority of the National Business and Technical Examination items for 2016 and 2017 were within the acceptable range of the discrimination parameter. On the other hand, the findings were contrary to the finding of Kasali, Opesemowo and Adeyemi (2022), who reported that the majority of items from the 2016 National Examination Council had poor discrimination power and were unable to effectively differentiate examinees. This implied that BECE BST for 2021/2022 in Borno State had a good discrimination parameter, as the majority of items were within the range of items with good discrimination ability.

The findings for research question three revealed that the pseudo-guessing parameter of the BECE BST test items for the 2021/2022 examinations was effective in minimizing the likelihood of students arriving at correct answers through random guessing. Where the majority of the items demonstrated low susceptibility to guessing, only a few were prone to it. This finding corresponded with the finding of Kasali, Opesemowo and Adeyemi (2022), who reported that the majority of multiple-choice items in the National Examination Council for 2016 were not vulnerable to guessing. Similarly, the findings aligned with finding Ajeigbe (2022), who reported effective guessing parameter of multiple-choice items of NECO 2022 academic session. However, the findings were contrary to the finding of Butakor (2022), who reported that the majority of multiple-choice items in senior high schools in Ghana were prone to guessing. This implied that the majority of BECE BST test items for 2021/2022 academic session were well-designed to ensure that students who selected correct responses did so based on their actual knowledge.

CONCLUSION

The study of the 2021/2022 BECE Basic Science and Technology (BST) test questions yielded significant insights into their overall quality and efficacy. The majority of the multiple-choice and essay exam items were found to be easy, with a smaller portion categorized as moderately difficult and very difficult. In terms of discrimination ability, the majority of the multiple-choice items, as well as all essay items, were able to discriminate between students with greater and lower abilities. However, a significant proportion of the multiple-choice items performed poorly in this respect. Furthermore, the pseudo-guessing study revealed that most items were structured to inhibit random guessing, implying that they tested genuine knowledge rather than luck. While the exam generally met acceptable requirements for difficulty, discrimination, and guessing minimisation, there is still potential for improvement, notably in improving the quality of questions that were either too easy or lacked the ability to effectively discriminate across students. Based on these findings, it is advised that instructors and test creators at the state and national levels take a professional development course on contemporary test creation methodologies.

Recommendations

Based on the study's findings the following recommendation were made:

1. The federal ministry of education through state education board should inforce a compulsory course on development and standardization for all those personnel constructing test for BECE BST at state and national level.

2. Use of item response theory in test calibration should be encourage and emphasis among all test developer at national and state level to bring out the effectiveness of each item to measure a particular trait rather assuming.

REFERENCES

Ainsworth, A. (2016). *Introduction to item response theory*. Retrieved from

http://www.csun.edu/ata201315/psy427/topic%2008IntroIRT.ppt.

Ajeigbe, T. O. (2022). Comparative validation analysis of biology multiple-choice test of the National Examination Council's in southwestern Nigeria from 2015–2017. *International Journal of Research in Education and Philosophy, 8*(1), 2455–4261.

Borno State Education Resource Centre. (2024). *Basic Education Certificate Examination result development centre*. Maiduguri, Borno State, Nigeria.

Bronchu, P. (2016). Using differential item functioning to investigate the impact of reading proficiency on science achievement (Unpublished doctoral dissertation). Ebonyi State University.

Joseph, M. E. (2023). *Predicting students' performance in Senior Secondary Certificate Examination from performance in Junior Secondary Certificate Examination in Borno State, Nigeria* (Unpublished project). Institute of Education, University of Maiduguri.

Kasali, J., Opesemowo, O. A. & Faremi, Y. A. (2022). Psychometric analysis of Senior Secondary School Certificate Examination 2017 National Examination Council English Language multiple-choice test item in Kwara State using item response theory. *Journal of Applied Research and Multidisciplinary Studies*, *3*(2), 2707–5095.

Lord, F. M. & Norvick, M. R. (1968). *Statistical theories of mental test scores*. Reading, MA: Addison-Wesley.

Nweke, C. O. (2021). *Predictive validity of students' achievement in basic science in Junior Secondary School Certificate Examination on their achievement in Senior School Certificate Examination in science subject* (Unpublished doctoral thesis). Department of Science Education, Ebonyi State University.

Obarasua, B. L. & Orluwene, G. W. (2022). Psychometric properties of 2018–2020 Basic Education Certificate Examination mathematics objective test items. *Journal of Psychology and Behavioural Science, 4*(1), 2663–6751.

Obarasua, B. L. & Orluwene, G. W. (2022). Psychometric properties of 2018–2020 Basic Education Certificate Examination mathematics objective test items. *Journal of Psychology and Behavioural Science, 4*(1), 2663–6751.

Solomon, A., Emaikwu, S. O. & Obinne, A. D. (2020). Comparative analysis of classical test theory and item response theory in estimating item difficulty of Basic Education Certificate Examination mathematics objective items in Makurdi-Nigeria. *World Journal of Innovative Research, 9*(2), 2454–8236.

Sunday, C. T. (2021). Basic science curriculum and development in Nigeria: Post COVID-19 challenges and prospects. *Journal of Educational Research and Policy Studies, 1*(2), 1–9. Retrieved from https://unijeps.org.

Universal Basic Education Commission. (2014). *Education for all is the responsibility of all*. Retrieved from https://ubec.gov.ng/

Cite this Article: Kaigama, ED; Dadughun, SI; Mustapha, AY (2025). An Item Response Theory (IRT) Based Assessment of Psychometric Properties of Basic Science and Technology Basic Education Certificate Examination in Borno State, Nigeria**.** *Greener Journal of Educational Research*, 15(1): 60-70**,** https://doi.org/10.15580/GJER.2025.1.042525075**.**