Greener Journal of Education and Training Studies

Vol. 9(1), pp. 42-46, 2026

ISSN: 2354-225X

https://gjournals.org/GJETS

DOI Link: https://doi.org/10.15580/gjets.2026.1.080526129

Examining the Model-Fit of Mathematics Basic Education Certificate Examination Items in Plateau Northern Zone, Nigeria.

Sadiya Baban-Mairam Abdullahi; Prof. Georginia C. Imo; Prof. Yusuf A. Mustapha

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

ABSTRACT

This study examined the model-fit of mathematics items in the Basic Education Certificate Examination (BECE) in Plateau Northern Zone, Nigeria. The quality of the examination items was assessed in terms of model-fit using Item Response Theory (IRT) approaches. A descriptive survey research design, specifically a cross-sectional survey design, was adopted. The population comprised 27,869 and 29,773 upper basic students' Mathematics BECE scripts for the years 2023 and 2024, respectively, drawn from 806 schools across six Local Government Areas in the zone. The sample was determined using 5% of the population of students scripts that wrote the Mathematics BECE for year 2023 and 2024. Using 5% of the school population, 40 schools were sampled 5 public schools (4 public urban and 1 public rural) and 35 private schools (32 private urban and 3 private rural). All the students' scripts in the 40 selected schools who sat for the Mathematics BECE in the year 2023 and 2024 were used for the study. These give 1,393 students' scripts in the year 2023. In 2024 the students' scripts were 1,487.The sample size satisfied the minimum requirement (N ≥ 1000) for stable parameter estimation under the three-parameter logistic model (3PLM). Data were obtained from the Mathematics BECE question papers and students' scripts for both years. Model fit of the examination items was determined. The findings revealed that the model fit for both 2023 and 2024 adequately fit the model. The study recommends the adoption of the IRT framework in BECE item analysis to enhance test quality and enable accurate placement of candidates based on their ability levels.

ARTICLE'S INFO

***Article No**.: 080526129*

***Type**: Research*

***Full Text:** PDF, PHP, HTML, EPUB, MP3*

***DOI:** 10.15580/gjets.2026.1.080526129*

***Accepted:** 05/08/2026*

***Published:** 14/08/2026*

***Keywords:** Mathematics, Model-Fit, Basic Education Certificate Examination*

***Corresponding Author**

Sadiya Baban-Mairam Abdullahi

***E-mail:** abdullahisadiya17@gmail.com*

***Phone:** 08069738850*

Article's QR code

INTRODUCTION

Mathematics is a core subject that plays a crucial role in understanding the world and serves as the foundation for scientific, technological and economic development. It involves the study of numbers, quantities, shapes and patterns and supports the development of critical thinking, logical reasoning, problem-solving and data literacy skills (Oluwatoyin & Matawal, 2019). In the Nigerian educational system, Mathematics is a compulsory subject from basic education to senior secondary school, reflecting its importance for academic success, career advancement and national development (Matawal, 2016). Mathematical proficiency is essential not only for academic achievement but also for everyday life and professional pursuits in fields such as science, engineering, finance and technology. Skills such as measurement, calculation, data analysis and interpretation are regularly applied in real-life situations. As a result, students' mathematical abilities provide insight into their cognitive development, readiness for higher education and future career opportunities (Ogunleye, 2018; Matawal, 2016).

Despite its importance, students' performance in Mathematics at the basic education level the results obtained over the years does not reflect the true ability of the students which affect their placement into the senior secondary school. This trend has raised concerns among educators, policymakers and other stakeholders about the effectiveness of Mathematics teaching and assessment practices (WAEC, 2020; NECO, 2021). Since examinations are central to evaluating students' learning outcomes and determining educational progression, it is necessary that test items meet established standards of quality, fairness and accuracy. Assessment is the process of evaluating students' knowledge, skills and understanding through various methods such as formative, summative and diagnostic assessments, with the aim of measuring learning outcomes and improving instructional effectiveness (Adebule & Ayodele, 2019).

Examining the model-fit of test items provides insight into how accurately and consistently an examination measures the intended construct. It also helps to identify if the items measure what it intend to measure (Bond & Fox, 2017). A good test item should be of valid (Anastasi & Urbina, 2019). Item Response Theory (IRT) provides a modern psychometric framework for evaluating test items by modeling the relationship between students' ability levels and their probability of answering items correctly. According to Embretson and Reise (2023), IRT estimates model-fit

One major advantage of IRT over Classical Test Theory (CTT) is parameter invariance. In CTT, item statistics depend heavily on the sample of examinees, limiting generalizability across populations (Hambleton, Swaminathan, & Rogers, 2021). In contrast, IRT produces item and ability estimates that are largely sample-independent, allowing for more accurate comparison of test items across different groups of students (Lord, 2020). This makes the three-parameter logistic model (3PLM) particularly suitable for analyzing multiple-choice Mathematics BECE items. Furthermore, IRT provides additional information through the Item Information Function (IIF) and Test Information Function (TIF), which indicate how much information individual items and the entire test provide across different levels of ability. These functions are useful for evaluating the precision and effectiveness of an examination (Baker & Kim, 2017). Given the increasing emphasis on data-driven decision-making and fair assessment practices in education. Therefore, this study examine the model-fit of Mathematics Basic Education Certificate Examination items in Plateau Northern Zone, Nigeria, with the aim of determining the quality, fairness and suitability of the items for effective measurement of students' mathematical abilities.

Aim and Objectives of the study

The aim of this study is to examine the model-fit of Mathematics Basic Education Certificate Examination items in Plateau North Senatorial Zone. The specific objectives are to:

1. determine the model fit of the Mathematics BECE items for the year 2023 in Plateau Northern Zone .
2. determine the model fit of the Mathematics BECE items for the year 2024 in Plateau Northern Zone .

Research Questions

The following research questions will be answered at the course of the study:

1. What is the model fit of the Mathematics BECE items for the year 2023?
2. What is the model fit of the Mathematics BECE items for the year 2024?

METHODOLOGY

This study adopted a descriptive survey research design, specifically a cross-sectional design, in which data were collected at a single point in time from a representative subset of the population in order to generalize the findings to the entire population. The design was considered appropriate because it allows for the description and analysis of existing conditions without manipulation of variables and acknowledges that outcomes may change over time due to interventions or contextual factors. The population of the study consisted of all upper basic students' Mathematics Basic Education Certificate Examination (BECE) scripts for the years

2023 and 2024 in Plateau Northern Zone, Nigeria. The total population comprised 27,869 scripts in 2023 and 29,773 scripts in 2024 drawn from 806 upper basic schools across six Local Government Areas. The scripts were drawn from both public and private schools and reflected variations by gender and school location (urban and rural). The use of students' Mathematics BECE scripts was considered appropriate because they contained the actual responses required for assessing the psychometric properties of the examination items.

The sample for the study was determined using 5% of the population of students scripts that wrote the Mathematics BECE for year 2023 and 2024 that will not be used for main study. Using 5% of the school population 40 schools were sampled 5 public schools (4 public urban and 1 public rural) and 35 private schools (32 private urban and 3 private rural). All the students' scripts in the 40 selected schools who sat for the Mathematics BECE in the year 2023 and 2024 were used for the study. These give 1,393 students' scripts in the year 2023 with 319 students scripts from public school, 153 scripts of male students and 166 scripts of female students and 1074 students' scripts from private schools, 507 scripts of male students and 565 scripts of female students. In 2024 the students' scripts were 1,487 with 334 students' script from public schools,165 scripts of male students and 169 scripts of female students and 1,153 students' scripts from private school , 579 scripts of male students and 574 scripts of female students.

The instruments for data collection were the Mathematics BECE question papers and students' response scripts for the years 2023 and 2024 obtained from the Plateau State Educational Resource Centre. These instruments were existing official examination documents. The validity of the items was determined through model fit analysis under Item Response Theory, while reliability was assessed using the test information function derived from item information functions to determine the precision and consistency of the test. Data were analyzed using inferential statistics based on Item Response Theory. The multiple-choice Mathematics BECE items were analyzed using X-Calibre version 4 and IRT PRO software.

RESULTS

Research Question One

What is the model fit of the Mathematics BECE items for the years 2023?

Table 1: **Model Fit of the Mathematics BECE Items for the Years 2023**

No	X^2	P	No	X^2	P	N	X^2	P
1	12.97	0.14	21	18.98	0.11	41	0.09	0.23
2	11.46	0.11	22	29.45	0.17	42	0.06	0.11
3	19.32	0.08	23	14.81	0.13	43	0.51	0.17
4	**18.71**	**0.01**	24	13.03	0.06	44	0.06	0.33
5	13.81	0.13	**25**	**22.75**	**0.02**	45	0.08	0.06
6	**24.67**	**0.02**	26	21.04	0.12	**45**	**0.07**	**0.02**
7	24.83	0.24	27	14.98	0.08	47	0.09	0.12
8	24.32	0.07	28	21.04	0.07	48	0.01	0.08
9	**50.67**	**0.01**	29	14.98	0.39	49	0.42	0.07
10	24.95	0.07	30	23.73	0.23	50	0.51	0.08
11	24.37	0.05	31	34.12	0.05	51	0.89	0.11
12	29.31	0.08	**32**	**23.54**	**0.01**	**52**	**0.91**	**0.04**
13	24.24	0.06	33	12.58	0.06	53	12.97	0.07
14	55.36	0.07	34	18.14	0.41	**54**	**11.46**	**0.03**
15	22.23	0.08	35	19.41	0.53	55	19.32	0.42
16	21.36	0.12	36	12.07	0.69	56	18.71	0.11
17	22.08	0.24	37	12.15	0.71	57	13.81	0.04
18	12.74	0.13	38	21.29	0.32	58	11.56	0.20
19	13.05	0.22	39	19.37	0.47	59	29.64	0.42
20	16.16	0.13	40	16.73	0.51	60	19.06	0.14

Table 1 shows the model fit analysis of the 2023 Mathematics BECE items, which indicates that the majority of the items functioned well according to the three-parameter model. Specifically, most items have Chi-square p-values greater than 0.05, suggesting that the observed responses were consistent with the model's expectations. However, 8 items exhibited misfit, which are items 4, 6, 9, 25, 32, 45, 52 and 54. These items may not conform well to the model due to unexpected response patterns, excessive difficulty or ease, ambiguous wording, or influences unrelated to the construct being measured. This implies that 88% of the items fit the model adequately, indicating that the 2023 Mathematics BECE test is largely reliable and measures the intended mathematics ability construct effectively.

Research Question Two

What is the model fit of the Mathematics BECE items for the years 2024?

Table 2: **Model Fit of the Mathematics BECE Items for the Years 2024**

No	X^2	P	No	X^2	P	N	X^2	P
1	9.96	0.87	21	9.06	0.11	41	23.18	0.62
2	22.55	0.54	22	28.01	0.42	42	9.33	0.84
3	28.55	0.24	23	17.28	0.51	43	11.81	0.06
4	29.70	0.33	24	5.34	0.89	44	16.21	0.08
5	15.08	0.24	25	8.04	0.91	45	20.51	0.53
6	18.16	0.11	26	4.46	0.81	46	6.09	0.89
7	28.46	0.09	27	8.21	0.92	47	18.21	0.21
8	17.17	0.64	28	6.91	0.98	**48**	**13.08**	**0.01**
9	78.03	0.03	29	21.01	0.07	49	11.92	0.53
10	12.68	0.07	30	16.12	0.08	50	3.11	0.97
11	33.2	0.08	31	11.05	0.60	51	14.06	0.08
12	18.3	0.10	32	9.38	0.31	52	18.32	0.20
13	10.4	0.71	**33**	**16.41**	**0.04**	53	9.48	0.61
14	18.11	0.09	34	21.04	0.18	54	7.21	0.89
15	16.2	0.06	35	30.08	0.74	**55**	**68.12**	**0.04**
16	17.0	0.51	36	26,11	0.61	56	4.46	0.81
17	11.02	0.06	37	12.76	0/31	57	8.21	0.92
18	13.8	0.08	38	18,01	0.47	58	6.91	0.98
19	12.01	0.07	39	12.54	0.71	59	21.01	0.07
20	10.21	0.09	40	`14.41	0.38	60	16.12	0.08

Table 2, the model fit analysis of the 2024 Mathematics BECE items indicates that most items demonstrated satisfactory conformity to the measurement model. Specifically, the majority of items align well with the model's expectations. Three items (33, 48 & 55) showed evidence of misfit. These items may not fit the model due to unusual response patterns, extreme difficulty or ease, ambiguous wording, or factors unrelated to the construct being measured. The findings suggest that the 2024 Mathematics BECE items largely (95%) fit the measurement model, with only 5% of items exhibiting misfit. This indicates that the test is generally reliable for assessing students' mathematics ability, though the misfit items may require review or revision to improve the validity of the test

DISCUSSION

The findings indicated that the Mathematics BECE items for both 2023 and 2024 largely fit the three-parameter logistic model, suggesting that the examinations effectively measured the intended mathematics ability construct. In 2023, 88% of the items fit the model, while 95% of the 2024 items demonstrated adequate fit, indicating an improvement in item quality across years. Item misfit in IRT typically reflected factors such as ambiguous wording, extreme difficulty or ease, multidimensionality, or guessing, which could distort measurement accuracy (Embretson & Reise, 2023). The low proportion of misfitting items supported the validity and reliability of the BECE Mathematics assessments, particularly in 2024 (Hambleton, Swaminathan, & Rogers, 2021).

CONCLUSION

This study examined the model-fit of Mathematics BECE items for 2023 and 2024 in Plateau Northern Zone using the three-parameter logistic model of Item Response Theory. The results indicate that the majority of items in both years demonstrated satisfactory model fit. The 2024 examination showed improved quality compared to 2023, with fewer misfitting items. The findings highlight the value of continuous item evaluation using IRT to enhance the quality, fairness, and effectiveness of large-scale examinations.

Recommendations

1. Examination bodies responsible for the Mathematics BECE should subject test items to regular item review using Item Response Theory before and after administration. Items that exhibit misfit, should be revised or replaced to improve test validity, reliability, and fairness.
2. Item writers and test developers should receive continuous training on modern test development practices, particularly in constructing well-functioning multiple-choice items with effective distracters and balanced fit, to enhance the overall quality of Mathematics BECE assessments.

REFERENCES

Adebule, S. O., & Ayodele, C. S. (2019). Assessment practices and students' learning outcomes in Nigerian secondary schools. *International Journal of Educational Research, 7*(2), 45–56.

Anikweze, C. M. (2018). *Measurement and evaluation for teacher education* (10th ed.). Ibadan: Adelaja.

Baker, F. B., & Kim, S. H. (2017). *The basics of item response theory using R*. Springer.

Embretson, S. E., & Reise, S. P. (2023). *Item response theory for psychologists* (2nd ed.). Psychology Press.

Hambleton, R. K., Swaminathan, H., & Rogers, H. J. (2021). *Fundamentals of item response theory*. Sage Publications.

Matawal, D. B. (2016). Mathematics education and national development in Nigeria. *Journal of Education and Practice, 7*(12), 67–74.

Odukoya, J. A. (2018). Psychometric evaluation of achievement tests in Nigerian schools. *African Journal of Educational Measurement and Evaluation, 4*(1), 21–34.

Oluwatoyin, C. O., & Matawal, D. B. (2019). Comparative analysis of Mathematics scores of students at secondary school level and tertiary institutions in Jos, Plateau State. *Nigerian Journal of Teachers Education and Teaching, 17*(1), 155–169.

Oluwatoyin, O. A., & Matawal, D. B. (2019). Mathematics education and problem-solving skills among Nigerian students. *Journal of Science and Mathematics Education, 6*(2), 14–25.

Cite this Article: Abdullahi, SB; Imo, GC; Mustapha, YA (2026). Examining the Model-Fit of Mathematics Basic Education Certificate Examination Items in Plateau Northern Zone, Nigeria**.** *Greener Journal of Education and Training Studies*, 9(1), 42-46**,** **https://doi.org/10.15580/gjets.2026.1.080526129.**