



An Analysis of Gender-based Differential Item Functioning of Basic Science and Technology Basic Education Certificate Examination in Borno State, Nigeria.

Kaigama, Emmanuel Daniel¹; Dadughun, Saurayi I.²; Mustapha, Yusuf A.³

1. Department of Science Education Measurement and Evaluation Unit Alex Ekwueme Federal University, Ndufu Alike, Ebonyi State, Nigeria. **Email:** emmanuel.kaigama@funai.edu.ng
2. Department of Educational Foundations Research, Measurement and Evaluation Unit, University of Jos, Plateau State, Nigeria. **Email:** dadughuns@unijos.edu.ng
3. Department of Educational Foundations Research, Measurement and Evaluation Unit, University of Jos, Plateau State, Nigeria. **Email:** bbsmusty@gmail.com

ABSTRACT

This study examined gender-based Differential Item Functioning (DIF) in the Basic Science and Technology (BST) items of the 2021/2022 Basic Education Certificate Examination (BECE) administered by the Borno State Education Board in Nigeria. Recognising the pivotal role of BST in preparing students for science education at higher levels. The study investigated whether the test items were equitable across gender lines. A survey research design was employed, using probability proportional to sample size technique to sample 3557 students' scripts from 51948 scripts of students who sat for BECE BST subject across 27 Local Government Areas in Borno State. The Mantel-Haenszel chi-square method was used to analyse DIF between male and female examinees. The results indicated that 77 out of 80 multiple-choice items and 9 out of 10 essay items were free from significant gender bias. Only three multiple-choice items and one essay items exhibited DIF against male students. The findings conclude that the majority of the BST items were fair and functioned equally across genders. The study concludes that the 2021/2022 BECE BST assessment was largely equitable and recommends that education boards enhance pre-testing and item review processes to further promote fairness and gender sensitivity in assessments.

ARTICLE'S INFO

Article No.: 052425088

Type: Research

Full Text: [PDF](#), [PHP](#), [EPUB](#), [MP3](#)

DOI: [10.15580/GJER.2025.1.052425088](https://doi.org/10.15580/GJER.2025.1.052425088)

Accepted: 25/05/2025

Published: 26/05/2025

Keywords: Gender, Differential item, Basic education Certificate Examination, Basic Science and Technology.

***Corresponding Author**

Kaigama Emmanuel Daniel

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

Article's QR code



INTRODUCTION

The education system of Nigeria encompasses three different levels: Basic education (nine years), senior secondary school (three years), and tertiary education (four to six years, depending on the programme of study). Basic education is a foundational education that prepares a child for the complexity of subjects at senior secondary school and higher education levels. The curriculum of Basic Education was developed in line with subjects at the senior secondary school level to ensure smooth academic progression and continuity in learning. 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 (BST) is a core subject at the basic education level that gives students a background in science subjects like Biology, Physics, and Chemistry at senior secondary school and higher education levels. 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 Communication Technology and Physical and Health Education were integrated to be called BST. The thematic integration of these subjects is to strategise 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 success in it serves as a qualification for studying science subjects at senior secondary school. This explains the emphasis given to BST in the basic education curriculum. The premium placed on science subjects strengthens their usefulness in the lives of the citizenry. Sunday (2021) noted that BST 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 BST curriculum is a broad field curriculum in which subject 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 also in Senior Secondary I (SSI) Biology. In Basic II BST, topics such as energy, chemicals, force, friction and gravity are found in Chemistry and Physics in SSI

and SSII. Moreover, topics like reflection and refraction of waves, electron flow and radioactivity are taught in Basic III and also in Physics and Chemistry in SSII and SSIII. 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 an examination conducted by the state education board at the end of upper basic education for the 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 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).

With the foregoing importance of the BST subject in the curriculum of basic education, items of BST should not function differentially for any candidate exposed to a test in BECE. The gender of examinees should not be a determinant of their performance in an examination. The performance of students in BST is determined through testing. The quality of a measuring instrument lies mainly in the quality of items used in the instrument. There is a need to ensure that items are reliable and fair to all across the subgroup of examinees (male & female). Test fairness is a crucial issue in testing, and it reflects the same constructs for all candidates and scores have the same meaning for all individuals in the intended population.

The first step in constructing assessment instruments is to ensure that no individual or group responding to the instrument is disadvantaged (Evans, Uko & Ekim 2022). For instance, in an achievement test, students of equal ability, usually drawn from the same population but belonging to different subgroups (male or female), should have the same probability of getting an item correct. Biased test items can differentially inhibit individuals from showing their true abilities, thereby measuring irrelevant constructs. Such items are said to be displaying differential item functioning (Galle, Gbande & Ibrahim, 2020). Indeed, DIF occurs when examinees from different sub-groups have different likelihoods of success on items after they have matched the ability of interest (Lim & Choe, 2023). The presence of DIF is a result of some characteristics in an item that result in differential performance for individuals of equal ability but from different sub-groups. Items may be judged relatively more or less difficult for a particular sub-group by comparison with the performance of another sub-group drawn from the same population. Differential item functioning of an item can therefore be understood as a lack of conditional independence between item response and group membership (often gender, location or ethnicity) given the same latent ability or trait (Omorogiuwa and Iro-Aghedo, 2016). Gender is the

range of physical, biological, mental and behavioural characteristics of masculinity and femininity (Wordu & Iwok, 2018). In the study, gender is a matter of grave concern, especially among academics and policy formulators. The importance of examining achievement concerning gender is based primarily on the bias of admission of male and female at senior secondary school level. Ogbogo and Okpara (2019) investigated differential item functioning using item response theory in the West African Senior School Certificate English Language test in South-South Nigeria. Their result revealed that the differential item functioning significantly depends on ethnic groups and functioned differentially based on gender difference. Olufemi and Oluseyi (2015) investigated items that show differential item functioning (DIF) in the English Language Multiple-Choice Uniform Promotion Examination Questions (ELMCUPEQ) of Ekiti State Ministry of Education for Senior Secondary School examinees based on gender and location. The results revealed that nine items possessed DIF in terms of gender and eleven items in terms of location. Their results revealed that items significantly function differentially in terms of gender.

The presence of differential item functioning in a test is determined using differential item functioning analysis. Pagano and Gotay (2015) referred to differential item functioning analysis as a procedure used to determine if test questions are fair and appropriate in assessing the knowledge of various groups present among the testees. This is based on the assumption that test takers with similar knowledge (based on the total score) should perform in the same ways on the individual test items regardless of their sex, race, or ethnicity (Effiom, 2021). It is worthy of note that a valid and reliable measuring instrument should provide all candidates with the same ability and equal opportunity of choosing the correct answer. Despite the perceived importance of establishing DIF in test development, it is observed that most state education boards are hesitant to engage in the practice involved in establishing the DIF of tests that will enhance the quality of items for BECE. Nweke (2021) reported that some of the state education boards wait until a few days before the BECE examination to construct test items, often copying direct questions from textbooks and repeating past question papers. The Borno State Education Board may be found wanting in this regard. This, therefore, calls for a need to assess the DIF of BECE BST test items in Borno State, Nigeria.

The purpose of this study is to ascertain whether the Borno State Education Board BECE BST test items constructed in 2021/2022 function differentially based on the gender of candidates. The findings on differential item functioning of the BECE BST in Borno State would be of great significance to students, teachers, school administrators and the Borno State Universal Basic Education Board. The result of this study, when it is completed and published, will benefit students by serving as their medium to communicate with the state education board on the state of the quality of BECE test items used to assess students and the need to develop fair and unbiased test items that all students, regardless of gender, 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 by encouraging 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 representation of student academic strength and areas for improvement. The findings of this study will also provide teachers with information on the extent to which they can rely on students' performance in BECE in predicting how students will perform in senior secondary school after the completion of this work and its publication. This study will be beneficial to school administrators in Borno State because it will expose the quality of test items they have been using to promote students into senior school after the completion and publication of this study. 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.

However, to accomplish the purpose of the study, the hypothesis was tested at a 0.05 level of significance. Items in Borno State BECE BST administered in 2021/2022 do not significantly function differentially between male and female examinees.

METHOD

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 51948 and 51435 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 probability proportional to size sampling technique was adopted to sample 3557 students' scripts from the total of 51948 students' scripts that sat for BECE BST within 27 LGAs in Borno State. The instrument for data collection was documents consisting of student's scripts and question papers for BST BECE for the 2021/2022 academic session in Borno State. The document consisting 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 objective test items were coded by entering the option (A, B, C or D) selected by the student for each item and specifying the correct answer by writing the key. Essay items were coded on a three-point scale using the polytomous model of the

generalized partial credit model for essay items. One (1) for a fair answer, two (2) for a correct answer and zero (0) for a wrong answer. Data were analyzed using the Mantel-Haenszel chi-square contingency method to test the hypothesis.

HYPOTHESES TESTING

Items of the 2021/2022 BECE BST do not significantly function differentially based on gender in Borno State, Nigeria.

The Mantel-Haenszel (M-H) coefficient was used to test hypothesis at 0.05 level of significant as presented in table below. The odd ratio less than 1.0 indicated that item was more to be correctly endorsed by reference group (male student) whereas, the odds ratios greater than 1.0 indicated that the female students were more likely to correctly endorse the item than the male students.

Table 1: Differential Item Function in BECE BST Test items for 2021/2022 Based on Gender (Male and Female)

Item ID	M-H	P	Remark	Item ID	M-H	P	Remark
1	1.07	0.951	No DIF	41	0.19	0.204	No DIF
2	2.08	0.685	No DIF	42	0.93	0.970	No DIF
3	1.81	0.638	No DIF	43	0.19	0.204	No DIF
4	1.67	0.657	No DIF	44	0.44	0.406	No DIF
5	1.13	0.924	No DIF	45	0.33	0.228	No DIF
6	0.57	0.500	No DIF	46	1.45	0.703	No DIF
7	0.46	0.635	No DIF	47	1.00	1.000	No DIF
8	0.28	0.117	No DIF	48	2.39	0.469	No DIF
9	0.72	0.718	No DIF	49	1.07	0.951	No DIF
10	4.25	0.297	No DIF	50	2.08	0.685	No DIF
11	2.06	0.514	No DIF	51	0.81	0.832	No DIF
12	0.74	0.765	No DIF	52	2.73	0.385	No DIF
13	1.82	0.597	No DIF	53	1.93	0.599	No DIF
14	0.96	0.966	No DIF	54	0.28	0.201	No DIF
15	0.16	0.154	No DIF	55	1.16	0.940	No DIF
16	2.50	0.323	No DIF	56	0.27	0.352	No DIF
17	0.28	0.169	No DIF	57	0.55	0.552	No DIF
18	0.42	0.376	No DIF	58	2.73	0.424	No DIF
19	5.23	0.294	No DIF	59	2.27	0.471	No DIF
20	2.74	0.329	No DIF	60	0.69	0.807	No DIF
21	1.11	0.928	No DIF	61	0.87	0.904	No DIF
22	0.39	0.449	No DIF	62	2.00	0.633	No DIF
23	2.35	0.423	No DIF	63	3.80	0.408	No DIF
24	1.58	0.705	No DIF	64	9.08	0.177	No DIF
25	0.35	0.210	No DIF	65	0.11	0.025	DIF/Male
26	14.67	0.160	No DIF	66	2.14	0.542	No DIF
27	0.53	0.565	No DIF	67	0.10	0.040	DIF/Male
28	0.51	0.515	No DIF	68	0.43	0.467	No DIF
29	0.32	0.271	No DIF	69	2.35	0.555	No DIF
30	8.00	0.280	No DIF	70	0.48	0.440	No DIF
31	0.06	0.017	DIF/Male	71	0.17	0.184	No DIF
32	1.16	0.896	No DIF	72	0.30	0.442	No DIF
33	0.13	0.113	No DIF	73	0.81	0.832	No DIF
34	0.34	0.458	No DIF	74	5.52	0.195	No DIF
35	0.54	0.469	No DIF	75	0.48	0.673	No DIF
36	0.57	0.547	No DIF	76	1.00	1.000	No DIF
37	4.72	0.207	No DIF	77	0.81	0.832	No DIF
38	3.77	0.314	No DIF	78	2.73	0.385	No DIF
39	0.22	0.269	No DIF	79	1.93	0.599	No DIF
40	0.93	0.970	No DIF	80	0.28	0.201	No DIF
Es1	0.048	0.961	No DIF	Es6	0.406	0.684	No DIF
Es2	0.033	0.973	No DIF	Es7	0.145	0.884	No DIF
Es3	0.011	0.991	No DIF	Es8	2.169	0.865	No DIF
Es4	3.151	0.879	No DIF	Es9	0.018	0.985	No DIF
Es5	0.164	0.869	No DIF	Es10	0.192	0.048	DIF/Male

P-value < 0.05 DIF; P-value > 0.05 No DIF

Note: n = 3557

M-H = Mantel Haenszel

The results in table 1 presented the analysis of differential item functioning of 2021/2022 BECE BST test items between male (reference group) and female students (focal group). The results revealed that 77 multiple-choice items (1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, 30, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 66, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79 & 80) did not function differently based on gender, except for items 31, 65, 67 of multiple choice items and item 10 of the essay items functioned differentially against male students, whereas the remaining nine items of the essay items did not function differently against any group. This implied that most of the 2021/2022 BECE BST multiple-choice and essay items were fair as majority of the items did not function differentially based on gender among secondary school students in Borno State.

RESULT AND DISCUSSION

Finding from hypothesis revealed the differential item functioning analysis of the 2021/2022 BECE BST based on gender differences. The findings indicated that most test items were fair across gender groups with only a few showing gender based bias. Seventy seven (77) multiple-choice items of BECE BST items (1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, 30, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 66, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79 & 80) did not function differently based on gender, except for items 31, 65, 67 of multiple choice items and item 10 of the essay items functioned differentially against male students, whereas the remaining nine items of the essay items did not function differently against any group. This implied that most of the 2021/2022 academic session were fair across gender groups with only a few showing gender based bias. These findings were in agreement with those of Ogbogo and Okpara (2019), who reported that the majority of the mathematics BECE questions of 2018 in Akwa Ibom did not function differentially based on gender. On the other hand, the findings were contrary to those of Olufemi and Oluseyi (2015), who reported differential item functioning (DIF) in the English Language Multiple-Choice Uniform Promotion Examination Questions (ELMCUPEQ) of Ekiti State Ministry of Education for Senior Secondary School examinees based on gender and location. This implied that the majority of BECE BST items in 2021/2022 were free from significant gender based differences in difficulty, supporting the fairness of the assessment across gender lines and indicating the success of the assessment in providing an equitable testing experience for students of different genders.

CONCLUSION

The analysis of Differential Item Functioning (DIF) in the 2021/2022 BECE Basic Science and Technology (BST) examination based on gender revealed that the majority of the test items were fair to both male and female students. Most of the multiple-choice and essay questions did not show any significant gender bias, with only a small number of items functioning differently in favour of one gender. This indicates that the assessment was largely free from gender-related differences in item difficulty and was generally equitable in evaluating students' knowledge regardless of gender.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made.

1. State education boards should enhance their pre-testing protocols and item review mechanisms to include rigorous screening for potential gender bias. Items should undergo expert review and statistical analysis before final selection.
2. Borna State education boards should continue to uphold the existing item development standards and validation processes that promote gender equity in assessments.
3. Examination bodies should investigate items identified as gender-biased and either revise or replace them. This proactive approach will help eliminate recurring sources of bias.
4. State education board should organise regular training sessions and workshops on equitable test development, item analysis and gender sensitivity in assessment for item writers.

REFERENCES

- Effiom, A. P. (2021). Test fairness and assessment of differential item functioning of Mathematics achievement test for senior secondary students in Cross River State, Nigeria using item response theory. *Global Journal of Educational Research*, 20, 55-62.
- Evans, G. U., Uko, M. P. & Ekim, R. E. D. (2022). *Investigation of differential item functioning of Basic Education Certificate Examination mathematics items in Akwa Ibom State, Nigeria*. Department of Educational Foundations, Akwa Ibom State College of Education, Afaha Nsit.
- Galle, S. A., Gbande, S. S. K. & Ibrahim, S. A. (2020). Analysis of differential item functioning of mathematics economic item structured test forms based on item difficulty levels in College of Education, Enugu State, Nigeria. *Journal of Innovation Research*, 9(5), 130-139.
- Lim, H. & Choe, E. M. (2023). Detecting differential item functioning in CAT using IRT residual DIF

- approach. *Journal of Educational Measurement*, 60(4), 626–650. <https://doi.org/10.1111/jedm.12325>.
- 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.
- Ogbogo, S. & Opara, I. M. (2019). Differential item functioning in English Language test using item response theory for ethnic groups. *Journal of Economics and Sustainable Development*, 10(6), 6-22.
- Olufemi, A. S. & Oluseyi, I. A. (2015). Differential item functioning of senior secondary school uniform promotion English Language multiple choice examination questions in Ekiti State. *International Advanced Journal of Teaching and Learning*, 1(2), 1-6.
- Omorogiuwa, K. O. & Iro-Aghedo, E. P. (2016). Determination of differential item functioning by gender in the National Business and Technical Examinations Board (NABTEB) 2015 mathematics multiple choice examination. *International Journal of Education, Learning and Development*, 4(10), 25-35.
- Pagano, I. S. & Gotay, C. C. (2015). Ethnic differential item functioning in the assessment of quality of life in cancer patients. *Health and Quality of Life Outcomes*, 3, 1–10.
- 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/>
- Wordu, H. & Iwok, U. A. (2018). Influence of gender and learning environment on students' academic achievement in Mathematics in Akwa Ibom State. *International Journal of Innovative Science & Science Education Research*, 6(1), 30-37.

Cite this Article: Kaigama, ED; Dadughun, SI; Mustapha, YA (2025). An Analysis of Gender-based Differential Item Functioning of Basic Science and Technology Basic Education Certificate Examination in Borno State, Nigeria. *Greener Journal of Educational Research*, 15(1): 96-101, <https://doi.org/10.15580/GJER.2025.1.052425088>.