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GENDER-RELATED DIFFERENTIAL ITEM FUNCTIONING OF THE WAEC MAY/JUNE MATHEMATICS MULTIPLE-CHOICE ITEMS IN OWERRI EDUCATION ZONE 1

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ABSTRACT

The research aimed at examining whether the 2019-2021 West African Examinations Council (WAEC) May/June mathematics multiple-choice questions exhibited gender differential item functioning (DIF) in Owerri Education Zone 1 of Imo State. A survey research design was employed. The number of sampled candidates used in the study was 2,484 secondary school students. This comprised 1,178 male and 1,306 female students. Through simple random sampling, two schools were obtained from the co-educational secondary schools in each of the five Local Government Areas. All SS3 students in the sampled schools were used for the study. Two research questions were formulated to guide the study. The instruments used for the study were the 2019, 2020 and 2021 May/June Multiple-choice mathematics questions set by the West African Examinations Council (WAEC). Each of the instruments consisted of 50-items. To detect the items that functioned differentially by gender, a software called STATA 15 of the logistics regression which is one of the classical test theory methods of DIF detection was applied. The results of the analysis revealed that some items functioned differentially based on gender. Twelve items (24%) in 2019, fifteen items (30%) in 2020 and eleven items (22%) in 2021 respectively, functioned differentially based on gender of the students. Sequel to the findings of the study, it was concluded that the WAEC May/June mathematics multiple-choice questions of 2019, 2020 and 2021 sets were not free from differential item functioning (DIF). It was also recommended among others that (1) West African Examinations Council and other Examination bodies should be carrying out differential item functioning analysis for all test items as part of test development process (2) Mathematics teachers should leave no stone unturned in devising ways of teaching those topics identified to be functioning differentially across groups.

Keywords: Gender, Differential Item Functioning, Mathematics, Education.

I. INTRODUCTION

Gender differences in scholastic mathematics achievement tests have generated a considerable interest in the field of educational and psychological testing. In recent years, there have been hundreds of studies that inspected differences in male and female performances in mathematics assessments with various results. Although male and female students are been taught in the same classrooms in most schools, there have been noticeable differences in Mathematics performance in many examinations. For instance, Tarfa and Dike (2022), stated that there is a significant difference in gender based academic performances of students in the West African Examinations Council (WAEC) mathematics from 2013 to 2017, in Yola, Adamawa State, Nigeria. Alade, Aletan and Sokenu (2020) reported that there was inequality in performance in the 2020 WAEC mathematics achievement test in Lagos State, Nigeria, with respect to gender

In examining this issue of gender differences in mathematics achievement, the stereotyped belief is that boys are better than girls in mathematics (Davis, 2008). In their own view, Oluyemo, Musbahu Kukwil, Anikweze and Shaluko (2020) revealed that male students exceled in mathematics more than their female counterparts in junior secondary schools in Niger State, Nigeria. Akpadaka and Oviogboda in Oribhabor (2015), in their study, found that male students perform better than female students in mathematics achievement test. Contrarily, Ma'Moon in Akissani, Muntari and Ahmed (2019), found that there was a significant gender difference in mathematics performance between male and female students. However, the difference was in favour of the

female students as they had significantly higher scores than the male students for logical thinking, mathematical proof, and for total mathematical achievement. The results of the study carried out by Oliweh and Oyem (2021) showed that there was no significant difference in the performance of Boys and girls. The overwhelming body of evidence suggests that gender-related differences in mathematics performance exist, and there is inconsistency regarding the pattern of differences (Liu, 2017).

Based on the foregoing, it is crystal clear that researchers have made extensive efforts to explore the existence of gender-related inequality in mathematics achievement test. But little has been done to determine whether the statistical differences in the mathematics achievement between boys and girls are due to items functioning differentially.

Ordinarily, it is expected that two individuals at the same level of a latent trait or ability, regardless of what group they belong to, will have the same probability of correctly or affirmatively responding to an item. If this is not true for an item, the item is said to be functioning differentially. Differential item functioning (DIF) occurs when individuals of the same ability level from separate groups have different probabilities of answering an item correctly (Annan-Brew, 2020). DIF is an indicator of bias observed when test takers from different groups have different probabilities or likelihood of responding correctly to an item, after controlling for ability. Sub groups typically studied in DIF analyses are examinees' characteristics such as gender, school type, religion and socioeconomic status. DIF is a threat to comparability and occurs if an item is easier for one group of test takers than for another after controlling for overall ability.

Differential item functioning (DIF) is an analysis of performance across groups on specific test items. It is a statistical technique that is used to identify differential item response patterns between groups of examinees such as male and female which helps in verifying potentially biased test items. DIF is of great interest to researchers and educators given that it poses a potential threat to test fairness. As an item analysis methodology different from comparing mean scores at test level, DIF plays an important role in detecting the items that function differentially in a test.

In the analysis of DIF, there are two major psychometric theories, which are classical test theory and item response theory and their corresponding models have been used for addressing differential item functioning studies. The current study is anchored on the classical test theory (CTT). In the classical test theory, the main concern of item analysis is to describe the statistical characteristics of each item. The total score of a test is considered the sum of scores on the individual items, and the individual item is of interest through its effect on the total test score. Thus, item analysis in classical test theory is focused on the degree to which each item influences the whole measurement.

A sizeable number of early studies on gender and mathematics test performance have been conducted to examine whether males and females have different performance in various tests. The overwhelming body of evidence suggests that gender-related difference in mathematics performance exist, and there is some consensus regarding the pattern of differences (Hyde, Fennema & Lamon cited in Liu, 2017). Alade, Aletan, and Sokenu (2020) investigated the differential item functioning of 2018 West African Senior School Certificate Examination (WASSCE) mathematics achievement test in Lagos State, Nigeria. Results demonstrated that six items (12%) out of the 50 items functioned differentially with respect to gender. Four items favoured female students while two items favoured male students.

Obiebi-Uyoyou (2023) carried out a study on assessment of differential item functioning in mathematics multiple-choice questions in senior secondary school certificate examination in Delta Central Senatorial District. The instruments used for collecting data were the WAEC/SSCE 2021 mathematics multiple-choice questions. The finding revealed that there was occurrence of gender, location, socio-economic, school type and school ownership differential item functioning in the WAEC/SSCE 2021 mathematics multiple-choice test items. With respect to gender, 24 items functioned differentially, representing 48% of the items. Among 24 items, twelve items (representing 24%) favoured the female students, while the other twelve items (representing 24%) favoured the male students. Okafor (2015) carried out a research on the analysis of gender and ethnicity-based differential item functioning in West African senior school certificate mathematics examination. The area of study was composed of three states, namely Katsina, Imo and Oyo. Major findings of the study indicated that 74% of items functioned differentially between male and female. Annan-Brew and Cobbinah (2020) carried out

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a gender-related differential item functioning of 2015 WASSCE core mathematics results in Southern Ghana using Logistic Regression procedure. The results showed that forty-three (43) items or 86% of the items revealed DIF. Out of the 43 items, 9 items revealed statistically significant uniform DIF, whereas 34 items revealed statistically significant non-uniform DIF. The nine items that revealed statistically uniform DIF had 5 items in favour of male candidates and 4 items in favour of female candidates, while the 34 items that showed statistically significant non-uniform DIF had 18 items in favour of male candidates and 16 items in favour of female candidates.

Purpose of the Study

The purpose of this study was to investigate the level to which DIF exists in mathematics achievement multiple choice questions administered by WAEC for senior secondary school certificate, ranging from 2019 - 2021 in terms of gender.

Research Questions

The following research questions guided the study

1. What percentage of items in each of the 2019, 2020 and 2021 May/June mathematics multiple-choice questions functioned differentially by gender?
2. What percentage of the items in each year showed DIF in favour of each gender?

II. METHOD

The research design adopted for this study was survey research design. According to Nworgu (2015), survey research design is one in which a group of people or items is studied by collecting and analyzing data from only a few people or items considered to be a representative of the entire group. This design was considered appropriate because only a part of the population was studied and findings were used to generalize for the entire population.

The study was carried out in Owerri Education Zone 1 of Imo State. The Zone is in the Eastern part of the State. It is made up of five (5) Local Government Areas which are; Ikeduru, Mbaitoli, Owerri Municipal, Owerri North and Owerri West. The Population of the study comprised all the SS3 students of the public secondary schools in Owerri Education Zone 1 of Imo State in the 2022/2023 academic session. There were 6 boys', 63 co-educational and 7 girls' secondary schools in the zone. The total number of the SS3 students was 9,886.

A combination of purposive sampling and simple random sampling was used for the sample selection. First, out of the 6 boys', 63 co-educational and 7 girls' secondary schools in the zone, the 63 co-educational secondary schools were purposively sampled to ensure that students from both gender groups came from the same schools. From the 63 co-educational secondary schools, two schools were obtained through simple random sampling from each Local Government Area. This gave rise to ten co-educational secondary schools. All SS3 students in the ten (10) sampled schools were used for the study, giving rise to 2484 students (1, 178 males and 1, 306 females).

The instruments used for data collection were the 2019, 2020 and 2021 WAEC May/June multiple-choice mathematics questions. Each of the instruments consisted of 50-items, and each item consists of a stem and a list of possible answers lettered A - D of which only one option is the correct answer. Each item of the instruments was scored 1 for correct option and 0 for wrong option with maximum score of 50 and minimum of 0 for the entire instruments.

The instruments had been validated by experts in the Test Development Division of the West African Examinations Council (WAEC) and therefore required no further validation since they were adopted. Thus, the items were considered appropriate in terms of subject contents and instructional objectives. On the other hand, being instruments of standardized international examination, which were conducted by the West Africa Examinations Council (WAEC), the instruments were deemed reliable. Hence, the reliability of the instruments was not established by the researchers.

To collect pertinent data needed for the study, the instruments were administered to the SS3 students in each of the sampled schools with the help of the mathematics teachers, who served as the research assistants. The researchers, through the teachers, informed the students ahead of time about the exercise and the need to be

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prepared because it would form part of their continuous assessment. This measure was to ensure that the students put in their best.

A software called STATA 15 was used to estimate the item parameters (item difficulty and item discrimination parameters) for the reference group (male students) and focal group (female students) for the determination of the differential item functioning (DIF) of the items. Data were analyzed using model equation for logistic regression so as to detect the items that functioned differentially in terms of the gender. The logistic regression model consists of two stages. First, the control variable, usually the "classical" total score, was included in the regression equation. Then, two other variables, related to the group (male and female) and the interaction group score, were included in the equation. The analysis consists in testing if the insertion of these two variables leads to a significant statistical result. For an item to be classified as displaying DIF, the two degrees-of-freedom Chi-squared test in logistic regression needed to have a p-vale less than or equal to 0.05 (Oratokhai, 2021).

III. RESULTS AND DISCUSSIONS

Research Question 1. What percentage of items in each of the 2019, 2020 and 2021 May/June mathematics multiple choice questions functioned differentially by gender?

To answer Research Question 1, Logistic regression for DIF was conducted based on gender. Female students in the study were referred to as focal group (coded 1), while male students were referred to as reference group (coded 0). Differential item functioning occurs when the value of Logistic regression test (LRT) of an item is significant ($p < .05$). The results obtained from the analysis are presented in Table 1, while the summary is presented in Table 2.

Table 1: DIF Analysis of 2019, 2020 and 2021 May/June Mathematics Multiple-Choice Questions Based on Gender

	2019			2020			2021		
Item	LRT	P-value	Remark	LRT	P-value	Remark	LRT	p-value	Remark
1	0.59	0.44	NO DIF	0.10	0.75	NO DIF	0.48	0.48	NO DIF
2	0.57	0.45	NO DIF	4.91	0.02	DIF	0.03	0.85	NO DIF
3	1.16	0.28	NO DIF	4.38	0.03	DIF	0.01	0.93	NO DIF
4	2.56	0.02	DIF	0.87	0.35	NO DIF	0.34	0.04	DIF
5	0.79	0.37	NO DIF	1.17	0.27	NO DIF	3.69	0.05	NO DIF
6	0.49	0.48	NO DIF	3.12	0.00	DIF	0.08	0.78	NO DIF
7	0.02	0.87	NO DIF	1.12	0.02	DIF	5.45	0.91	No DIF
8	0.50	0.48	NO DIF	0.13	0.01	DIF	1.26	0.26	NO DIF
9	0.41	0.52	NO DIF	1.62	0.00	DIF	0.65	0.42	NO DIF
10	0.77	0.37	NO DIF	1.62	0.00	DIF	0.01	0.90	NO DIF
11	0.00	0.96	NO DIF	0.21	0.65	NO DIF	0.28	0.59	NO DIF
12	0.80	0.37	NO DIF	3.96	0.04	DIF	0.24	0.62	NO DIF
13	1.46	0.01	DIF	3.96	0.04	DIF	0.05	0.82	NO DIF
14	0.00	0.97	NO DIF	1.02	0.31	NO DIF	0.71	0.01	DIF
15	0.44	0.50	NO DIF	.00	0.95	NO DIF	0.34	0.56	NO DIF
16	2.04	0.15	NO DIF	2.82	0.42	NO DIF	0.01	0.92	NO DIF
17	0.00	0.96	NO DIF	3.34	0.06	NO DIF	1.26	0.26	NO DIF
18	0.33	0.56	NO DIF	0.54	0.46	NO DIF	1.52	0.21	NO DIF
19	0.00	0.98	NO DIF	6.06	0.00	DIF	3.13	0.01	DIF

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20	0.07	0.79	NO DIF	0.36	0.00	DIF	0.21	0.64	NO DIF
21	0.08	0.78	NO DIF	0.36	0.54	NO DIF	0.01	0.92	NO DIF
22	1.57	0.21	NO DIF	0.03	0.85	NO DIF	0.11	0.74	NO DIF
23	0.00	0.98	NO DIF	0.05	0.83	NO DIF	17.50	0.00	DIF
24	2.93	0.08	NO DIF	0.46	0.49	NO DIF	4.90	0.02	DIF
25	2.43	0.11	NO DIF	0.33	0.56	NO DIF	5.73	0.01	DIF
26	1.96	0.00	DIF	1.69	0.19	NO DIF	0.14	0.71	NO DIF
27	0.81	0.36	NO DIF	0.08	0.78	NO DIF	0.09	0.76	NO DIF
28	0.00	0.03	DIF	0.02	0.87	NO DIF	0.04	0.84	NO DIF
29	0.71	0.01	DIF	0.93	0.33	NO DIF	0.00	0.95	NO DIF
30	0.78	0.02	DIF	0.10	0.08	NO DIF	1.61	0.20	NO DIF
31	2.12	0.14	NO DIF	2.36	0.02	DIF	1.18	0.27	NO DIF
32	6.06	0.01	DIF	0.02	0.90	NO DIF	0.55	0.45	NO DIF
33	0.20	0.65	NO DIF	4.09	0.06	No DIF	0.00	0.95	NO DIF
34	0.95	0.33	NO DIF	0.14	0.71	NO DIF	1.16	0.28	NO DIF
35	0.13	0.71	NO DIF	1.04	0.30	NO DIF	4.71	0.03	DIF
36	0.82	0.36	NO DIF	1.19	0.27	NO DIF	0.26	0.61	NO DIF
37	1.82	0.00	DIF	1.80	0.18	NO DIF	0.54	0.46	NO DIF
38	1.37	0.24	NO DIF	1.67	0.03	DIF	0.39	0.52	NO DIF
39	0.32	0.02	DIF	2.31	0.12	NO DIF	0.31	0.57	NO DIF
40	0.01	0.90	NO DIF	1.85	0.17	NO DIF	2.12	0.14	NO DIF
41	0.01	0.93	NO DIF	5.73	0.09	NO DIF	2.09	0.14	NO DIF
42	2.96	0.01	DIF	0.19	0.66	NO DIF	0.69	0.00	DIF
43	0.12	0.73	NO DIF	3.08	0.07	NO DIF	0.46	0.02	DIF
44	3.33	0.02	DIF	3.22	0.02	DIF	3.12	0.07	NO DIF
45	0.32	0.56	NO DIF	2.57	0.10	NO DIF	3.92	0.04	DIF
46	5.59	0.01	DIF	3.13	0.07	NO DIF	2.21	0.13	NO DIF
47	0.28	0.60	NO DIF	1.18	0.27	NO DIF	0.78	0.37	NO DIF
48	0.00	0.98	NO DIF	0.05	0.82	NO DIF	0.01	0.01	DIF
49	0.49	0.48	NO DIF	1.63	0.20	NO DIF	0.01	0.94	NO DIF
50	1.43	0.23	NO DIF	0.82	0.36	NO DIF	0.01	0.90	NO DIF

Table 2: Percentage of Items that Displayed DIF Based on Gender in 2019,2020 and 2021 WAEC May/June Mathematics Multiple-Choice Questions

Year	NO. of Items	No of items with DIF	% of items with DIF	Items with DIF
2019	50	12	24 %	4, 13, 26, 28, 29, 30, 32, 37, 39, 42, 44, 46
2020	50	15	30%	2, 3, 6, 7, 8, 9, 10, 12, 13, 17, 19, 20, 31, 38, 44
2021	50	11	22%	4, 14, 19, 23, 24, 25, 35, 42, 43, 45, 48

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Table 2 shows that 12 items, that is, Items 4, 13, 26, 28, 29, 30, 32, 37, 39, 42, 44, and 46, (representing 24% of the total items in the WAEC 2019 May/June mathematics multiple-choice questions) displayed differential item functioning. In 2020, 15 items, that is, Items 2, 3, 6, 7, 8, 9, 10, 12, 13, 17, 19, 20, 31, 38 and 44, (representing 30% of the of the total items in the WAEC 2020 May/June mathematics multiple-choice questions) displayed differential item functioning, while in 2021, 11 items, that is, Items 4, 14, 19, 23, 24, 25, 35, 42, 43, 45 and 48, (representing 22% of the total items in the WAEC 2021 May/June mathematics multiple-choice questions) displayed differential item functioning. The gender DIF items may be due to the fact that they contain sources of difficulty that were irrelevant or extraneous to the construct being measured. These results agree with similar research result reported by Alade, Aletan, and Sokenu (2020). Their result showed that there was evidence of gender DIF in 2018 WASSCE in Lagos State, which demonstrated that six items (12%) out of the 50 items functioned differentially with respect to gender. The results also agree with the submission of Okafor (2015) where she posited that 74% of items of the mathematics multiple choice test prepared by the West African Examinations Council in 2012 functioned differentially between male and female. Again, the results of the current study agree with Obiebi-Uyoyou (2023). According to him, the mathematics multiple-choice test used by WAEC in 2021 in Delta State Central Senatorial District also contained test items with significant gender DIF. He maintained that out of the 50 items, 24 items functioned differentially, representing 48% of the items. Tests should provide equal opportunities to all examinees without bias, to demonstrate their abilities and knowledge irrespective of their socio-demographic factors like gender, location, religious and cultural groups (Amaechi, Eluwa & Madu, 2020). Fairness is an essential quality of a test; its equitable treatment of all examinees during the testing process, absence of measurement bias, equitable access to the constructs being measured, and justifiable validity of test score interpretation for the intended purpose (Effiom, 2019).

Research Question 2. What percentage of the items in each year showed DIF in favour of each gender?

To answer Research Question 2, the odds ratio of logistic regression for DIF was computed based on gender. Female students in the study were referred to as focal group (coded 1), while male students were referred to as reference group (coded 0) as previously mentioned. Differential item functioning occurs in favour of female students when the odds ratio of Logistic Regression Test (LRT) of an item is significant ($p < .05$) and the odd ratio is greater than 1. The results obtained from the analysis are presented in Table 3, while the summary is presented in Table 4.

Table 3: Items That Showed DIF in Favour of Each Gender in 2019, 2020 And 2021 May/June Mathematics Multiple-Choice Questions

	2019			2020			2021		
Item	Odds Ratio	p-value	Remarks	Odds Ratio	p-value	Remarks	Odd Ratio	p-value	Remarks
1	0.75	0.44	NO DIF	1.11	0.75	NO DIF	0.65	0.48	NO DIF
2	0.78	0.45	NO DIF	1.68	0.02	DIF Female	1.14	0.85	NO DIF
3	1.40	0.28	NO DIF	1.95	0.03	DIF Female	1.07	0.93	NO DIF
4	0.69	0.02	DIF Male	0.75	0.35	NO DIF	0.82	0.04	DIF Male
5	0.80	0.37	NO DIF	1.39	0.27	NO DIF	0.55	0.05	NO DIF
6	1.18	0.48	NO DIF	0.52	0.00	DIF Male	1.10	0.78	NO DIF
7	1.06	0.87	NO DIF	0.73	0.02	DIF Male	1.93	0.91	NO DIF
8	1.20	0.48	NO DIF	1.14	0.01	DIF Female	1.40	0.26	NO DIF
9	1.17	0.52	NO DIF	1.48	0.00	DIF Female	0.78	0.42	NO DIF
10	1.25	0.37	NO DIF	0.69	0.00	DIF Male	1.07	0.90	NO DIF

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11	0.96	0.96	NO DIF	1.20	0.65	NO DIF	0.84	0.59	NO DIF
12	0.79	0.37	NO DIF	1.67	0.04	DIF Female	0.85	0.62	NO DIF
13	0.76	0.01	DIF Male	0.58	0.04	DIF Male	0.91	0.82	NO DIF
14	0.96	0.97	NO DIF	0.72	0.31	NO DIF	1.34	0.01	DIF Female
15	0.84	0.50	NO DIF	1.07	0.95	NO DIF	1.21	0.56	NO DIF
16	0.71	0.15	NO DIF	1.57	0.42	NO DIF	1.01	0.92	NO DIF
17	1.03	0.96	NO DIF	1.65	0.06	DIF Male	1.39	0.26	NO DIF
18	0.86	0.56	NO DIF	0.80	0.46	NO DIF	0.68	0.21	NO DIF
19	1.02	0.98	NO DIF	1.97	0.00	DIF Female	0.57	0.01	DIF Male
20	0.92	0.79	NO DIF	0.69	0.00	DIF Male	0.85	0.64	NO DIF
21	0.91	0.78	NO DIF	1.18	0.54	NO DIF	0.94	0.92	NO DIF
22	0.74	0.21	NO DIF	0.92	0.85	NO DIF	1.13	0.74	NO DIF
23	1.02	0.98	NO DIF	0.91	0.83	NO DIF	3.05	0.00	DIF Female
24	1.51	0.08	NO DIF	1.24	0.49	NO DIF	1.83	0.02	DIF Female
25	1.45	0.11	NO DIF	0.83	0.56	NO DIF	0.52	0.01	DIF Male
26	0.72	0.00	DIF Male	1.62	0.19	NO DIF	0.87	0.71	NO DIF
27	1.26	0.36	NO DIF	0.89	0.78	NO DIF	0.88	0.76	NO DIF
28	1.01	0.03	DIF Female	0.91	0.87	NO DIF	0.91	0.84	NO DIF
29	0.81	0.01	DIF Male	0.74	0.33	NO DIF	1.05	0.95	NO DIF
30	1.81	0.02	DIF Female	1.11	0.08	NO DIF	1.47	0.20	NO DIF
31	1.47	0.14	NO DIF	0.64	0.02	DIF Male	1.36	0.27	NO DIF
32	1.81	0.01	DIF Female	1.06	0.90	NO DIF	0.77	0.45	NO DIF
33	1.12	0.65	NO DIF	0.54	0.06	NO DIF	1.02	0.95	NO DIF
34	1.25	0.33	NO DIF	0.87	0.71	NO DIF	0.72	0.28	NO DIF
35	1.11	0.71	NO DIF	0.73	0.30	NO DIF	0.51	0.03	DIF Male
36	1.26	0.36	NO DIF	1.34	0.27	NO DIF	1.17	0.61	NO DIF
37	0.73	0.00	DIF Male	1.51	0.18	NO DIF	1.24	0.46	NO DIF
38	1.33	0.24	NO DIF	1.41	0.03	DIF Female	0.81	0.52	NO DIF
39	0.86	0.02	DIF Male	0.64	0.12	NO DIF	1.21	0.57	NO DIF
40	1.04	0.90	NO DIF	1.45	0.17	NO DIF	1.54	0.14	NO DIF
41	1.01	0.93	NO DIF	0.52	0.09	NO DIF	1.56	0.14	NO DIF
42	0.67	0.01	DIF Male	0.87	0.66	NO DIF	1.77	0.00	DIF

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									Female
43	0.90	0.73	NO DIF	0.57	0.07	NO DIF	0.80	0.02	DIF Male
44	1.66	0.02	DIF Female	0.63	0.02	DIF Male	0.59	0.07	NO DIF
45	0.85	0.56	NO DIF	0.63	0.10	NO DIF	1.75	0.04	DIF Female
46	1.74	0.01	DIF Female	1.60	0.07	NO DIF	0.64	0.13	NO DIF
47	1.14	0.60	NO DIF	1.37	0.27	NO DIF	0.76	0.37	NO DIF
48	0.97	0.98	NO DIF	1.08	0.82	NO DIF	0.99	0.01	DIF Male
49	1.18	0.48	NO DIF	0.69	0.20	NO DIF	1.05	0.94	NO DIF
50	1.34	0.23	NO DIF	1.28	0.36	NO DIF	1.07	0.90	NO DIF

Table 4: Percentage of Items that Displayed DIF in Favour of Male and Female Students in the 2019, 2020 and 2021 WAEC May/June Mathematics Multiple-Choice Questions

Year	NO. of Items	DIF	DIF in Favour of Male Students	DIF in Favour of Female Students
2019	50	12	7 (14 %)	5 (10 %)
2020	50	15	8 (16 %)	7 (14 %)
2021	50	11	6 (12 %)	5 (10 %)

Table 4 shows that out of 50 items in WAEC 2019 May/June Mathematics multiple-choice questions, 12 possessed DIF. Out of the 12 items that were flagged DIF, 7 (Items 4, 13, 26, 29, 37, 39 and 42, representing 14 %) of them were in favour of male students and 5 (Items 28, 30, 32, 44 and 46, representing 10 %) were in favour of female students. In 2020, 15 items out of 50 items were flagged DIF. Out of the 15 that were flagged DIF, 8 (Items 6, 7, 10, 13, 17, 20, 31 and 44, representing 16 %) were in favour of male students while 7 (Items 2, 3, 8, 9, 12, 19 and 38, representing 14 %) were in favour of female students. In 2021, 11 items were flagged DIF out of the 50 items. Out of the 11 items flagged DIF, 6 items (4, 19, 25, 35, 43 and 48, representing 12 %) were in favour of male students while 5 items (14, 23, 24, 42 and 45, representing 10 %) were in favour of female students. The results of the study are in tandem with similar research result reported by Alade, Aletan, and Sokenu (2020), in which among the 6 items that functioned differentially in WASSCE multiple-choice questions in 2018, Items 28, 37, 43 and 46 (8%) favoured female students, while Items 31 and 35 (4%) favoured male students. The results of the current study also supported the findings of Obiebi-Uyoyou (2023) in which he revealed that among the 24 items that functioned differentially in WASSCE multiple-choice questions in 2021, twelve (3, 6, 9, 10, 11, 14, 15, 18, 23, 24 and 25, representing 24% of all the items) favoured the female students, while the other twelve items (2, 4, 5, 7, 8, 12, 13, 16, 17, 20, 21 and 22, representing 24% of all the items) favoured the male students. When test possesses DIF, it could bring about low achievement for a minority group in a subject matter and this can hamper the meaning of test outcomes and decision that is based on it for some groups, especially core subject like mathematics which is a compulsory criterion for further educational advancement. Therefore, it is important that tests be fair to all and not biased against any group.

IV. CONCLUSION

Based on the findings of this study, it was concluded that the WAEC May/June mathematics multiple choice questions were not free from differential item functioning (DIF). Therefore, WAEC results for students in the senior secondary schools in mathematics may not be as valid as they should be. Mathematics Examinations from the West African Examinations Council (WAEC) seem to be unfair to some students based on their gender. Thus, gender affects scholastic achievements in mathematics.

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V. RECOMMENDATIONS

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

1. West African Examinations Council and other Examination bodies should need to carry out differential item functioning analysis for all test items as part of test development process. This is needed because of large population of students that take the examinations. These students are from different demographic backgrounds, like gender, ethnic group, etc. Analyzing items for differential functioning would help the examination bodies to identify items that are biased.
2. During item writing, WAEC and other examination bodies should be more stringent in their approach, and item reviewers should take cognizance of differentially functioning of items.
3. Mathematics textbooks authors are encouraged to be aware of existence of DIF in some Mathematics topics. The authors should endeavour to present their works in a manner that would help to minimize the issue of DIF. Illustrations, presentations, words and language in general, should, as much as possible, reflect what is universally applicable to all.
4. Government and authorities concerned should always strike a balance while appointing members of examination bodies to ensure fair representation. This is necessary to ensure that members of examination bodies are selected from different groups, particularly those against whom some items show differential functioning.

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