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EQUATING 2022 WAEC MAY/JUNE AND NECO JUNE/ JULY MATHEMATICS MULTIPLE CHOICE EXAMINATIONS USING LINEAR EQUATING METHOD

BY

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Abstract

The equating of educational assessments serves as a crucial component in ensuring fairness and comparability across different examination boards. This study aimed to equate the 2022 WAEC May/June and NECO June/July Mathematics multiple-choice examinations using the linear equating method. Specifically, the study establishes a statistical procedure that aligns the ability parameters, and determined the difficulty and discrimination parameters of the two examinations. The methodology involves the collection and analysis of item response data from a representative sample of 1,486 SS3 students in seven (7) selected public secondary schools in Yenagoa Metropolis, Bayelsa State using multi-stage sampling procedure. Three research questions were answered with descriptive statistics (mean and standard deviation), while two hypotheses were tested using independent sampled t-test statistics at 0.05 alpha level of significant. The findings of this study revealed that the 2022 WAEC May/June scores is equivalent to the 2022 NECO June/July scores using linear equating method; there is no significant difference in the item difficulty parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations; and there is a significant difference in the item discrimination parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations. The study recommends that the examination bodies should implement quality assurance mechanisms to monitor the consistency and accuracy of discrimination level evaluation across test items.

Keywords: Equating, Mathematics, Linear Equating, Multiple choice and Test Items

Introduction

One of the main goals of student testing in schools is to generate results that are frequently utilized for selection, advancement, and certification, among other crucial judgments. Test results are used by schools to determine who gets promoted, external examining bodies to determine who gets certified, higher education institutions to determine who gets admitted and for what course, and recruiting agencies to determine who gets chosen. Test results are evaluated at the senior secondary school level in order to determine a student's eligibility for senior school certification and admission to postsecondary education institutions. The scores ought to represent the most accurate assessments of abilities and skills because the choices made based on them are significant to both the public and the individuals who receive them. There are several obstacles in the way of teachers and external examiners when it comes to evaluating students, obtaining scores with fair and impartial evaluation, and lowering complexity. Fair and equal treatment of examinees that is congruent with their real performance on the test they took was stressed by Doran et al., (2010).

In Nigeria, the West African Examination Council (WAEC) and National Examination Council (NECO) are two prominent examination bodies that administer examinations to school candidates in the third year of their Senior Secondary School. The examination measures the extent to which the candidates have understood the content of the teaching curriculum approved by the country (Ahmed, 2014). The goal of the WAEC and NECO's frequent assessments of their test administration methods is to reduce distortions and produce extremely dependable scores. The testing boards and schools in Nigeria employ different statistical features for their assessments, which are contingent on the distinctiveness of the population intended for them. The features of different educational institutions' administrations, teachers, and testing organizations differ as well.

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Major stakeholders have expressed a variety of concerns regarding the validity of the inspections carried out by both organizations (NECO and WAEC). Among the complaints are the following: exam malpractices, inequalities in performance, large-scale paper leaks, crammed exam rooms, and non-equivalency in the quality of the exam items. Babatimehin (2021) claims that some Federal colleges rejected NECO results between 2002 and 2012 due to the NECO's subpar quality. According to Ahmed (2014), WAEC questions were worse quality than NECO questions from 2011 to 2014. According to Ojerinde & Faleye (2005), a comparison of NECO and WAEC revealed no differences. The researchers were particularly concerned about the allegations leveled against these testing boards regarding the non-equivalency of the items with respect to difficulty, discrimination, and student performance disparities.

One significant issue that WAEC and NECO need to address head-on is standard comparison, which is related to equivalency in quality of assessment instrument as well as honesty in scoring and reporting results. It is crucial to ensure test scores are comparable because it is nearly hard to create equivalent test forms. Test equating can be used to achieve the equivalency of test results from two or more exams (Chong & Sharon, 2005). Test equating can be used to measure and regulate variations in test difficulty as well as other statistical features of distinct test scores. To ensure comparability in terms of difficulty and discrimination, test equating is for comparing scores (Kolen & Brennan, 2014). Test equating, according to Wendy (2002), is a statistical process that measures and accounts for differences in test difficulty (as well as other statistical features) so that scores on equated tests have a similar meaning. The process of comparing test results from many test forms given to examinees or groups of examinees is known as "test equating." The process of equating enables the test users to interchange multiple forms of a test (Chong & Sharon, 2005). An empirical method for determining the correlation between the raw results of two or more test forms is called "test equating." The use of test equating enables scholars to represent test results from one version to another (Doran & Holland, 2000; Van der Linden, 2006). Test equating, as defined by the definitions provided by the several writers above, is the process of placing test results on a common scale for students who took multiple versions of the same exam. The test results are actually utilized when test equating is conducted. This is the reason most literature refers to it as test score equating.

Ayanwale (2023) used Haebara Item Response Theory (IRT) and sang Stocking-Lord to equalize the multiple-choice questions in WAEC and NABTEB Mathematics. 1210 Grade 12 students were chosen for the study, and they were split into groups A (647) and B (563). The results show that while WAEC is more challenging and has superior discrimination, its construct domains are similar to those of NABTEB. Furthermore, both exams are comparable when put on the same scale. Olanigan et al., (2022) studied the efficiency of linear equating methods in estimating students' ability estimates in public and private secondary schools, using a descriptive research design. The study involved a sample of 1,139 candidates from public and private schools found that private school candidates had higher ability scores compared to public school candidates. The results showed significant differences in ability estimates between the two groups, with the linear equating method being more efficient. The study used secondary data. Moreover, Aborisade and Fajobi (2020) examined the comparability of the psychometric properties of the items constructed by the two examination bodies (WAEC and NECO). The study employed descriptive research design of the survey type. The population for the study comprised all Senior Secondary School Students who enrolled for 2019 WAEC and NECO examinations in South West, Nigeria. The sample for the study consisted of 1,200 Senior Secondary School Students selected using multistage sampling procedure. The findings of the study showed that the difficulty index of Mathematics items constructed by the two examination bodies are comparable while the discriminating powers are not comparable.

Adeyemo (2019) used a linear test score equating approach to compare items in Ekiti's Senior Secondary School III. With 360 students from three senatorial districts, the study used the 2015 WAEC (MAT A) and Ekiti State Unified Examinations (MAT B) as instruments. The study analyzed MAT A and B data and tested hypotheses using t-test statistics and linear test score equating method. Results showed significant differences in difficulty indices, discrimination power, and student performance between the two exams. Furthermore, Kolawole (2017)

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compared the psychometric properties of WAEC and NECO Mathematics multiple choice test items, whether the two papers are equivalent tests. The sample of the study is made up of 500 senior secondary school students who were randomly selected from ten Local Government Areas of Ekiti State, Nigeria. The findings of the study revealed that there was no significant difference between their difficulty level indices, and discrimination power.

Statement of the Problem

Standardized exams are primarily intended to give an impartial and fair way to assess the talents of a group of candidates. This goal of using test results is to assess the abilities and/or capabilities of candidates who strive to achieve the highest grade in the Senior Secondary Certificate Examination (SSCE). Therefore, it is crucial that the results of standardized tests offer a just and equal assessment of the knowledge and abilities they are meant to gauge. Furthermore, it is quite difficult to create many test versions with identical psychometric characteristics. For this reason, it is necessary to equate the two examinations that were given to the two distinct groups of students. The examination bodies such as WAEC and NECO are responsible for conducting certificate examination in Nigeria, these professional examination bodies are designed to serve the same purpose and to issue certificates to qualified candidates. There is a general perception that one form of this examination is easier to pass than the other, but these perceptions do not have a dependable position or empirical stands, error could be possible about the judgment made by the general perception of the public about the examination if they were designed to serve the same purpose. In other words, one examinee may take a form of a test with more difficult items than those taken by another examinee. Unless the fairness and equity of the test are ensured, test scores from multiple test forms cannot be utilized interchangeably.

To the best of the researchers' knowledge, equating had not been carried out using Bayelsa State secondary schools, and in Mathematics subject which is a core subject in secondary schools. This study seeks to find out if the scores from the two forms of examinations (2022 WAEC May/ June and NECO June/July) which are designed to serve the same purpose and cover the same syllabus can be used interchangeably using linear equating method.

Purpose of the Study

The main purpose of this study is to empirically investigate the use of linear equating method in the comparison of students' 2022 WAEC May/ June and 2022 NECO June/July Mathematics scores. Specifically, this study seeks to:

1. Ascertain the results of linear equating of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice examinations.
2. Determine the difference in the difficulty levels of the 2023 WAEC May/ June and 2023 NECO June/ July Mathematics multiple choice examinations.
3. Ascertain the difference in the discrimination levels of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice examinations.

Research Questions

The following research questions were raised to guide the study:

1. What are the results of linear equating of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations?
2. What are the item difficulty parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations?
3. What are the item discrimination parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations?

Hypotheses

The following hypotheses were formulated from research questions.

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1. There is no significant difference in the item difficulty parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations.
2. There is no significant difference in the item discrimination parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations.

Methodology

The research design that was adopted for this study is the survey research design. This design was considered useful because only a part of the population was studied and findings from this were used to generalize for the entire population. The population of this study consists of all SS3 students (2022/2023 academic session) in public senior secondary schools in Yenagoa metropolis, Bayelsa State. There are twenty-three (23) public secondary schools in Yenagoa metropolis with total number of 4,953 in senior secondary three (SS3). The sample size comprises of one thousand four hundred and eighty-six (1486) SS3 students in seven (7) selected public secondary schools in Yenagoa metropolis using multi-stage sampling procedure. The sample sizes for the students and the schools were gotten from the 30% of the population. The instruments that were used to gather data were 2022 WAEC May/June and NECO June/July Mathematics Multiple Choice items. The West Africa Examination Council (WAEC) and National Examination Council (NECO) test items that were used in collecting data have been standardized by the examination boards. The examination boards have the credit and claims for employing appropriate procedures for the validation of their test items, therefore, it is assumed that the items satisfied content and face validity. Cronbach alpha technique was used to estimate the reliabilities of the 2022 WAEC May/June and NECO June/July Mathematics multiple choice items, and reliability coefficients of 0.89 and 0.88 were obtained respectively.

The instruments were administered to the students by the researchers with the assistance of their Mathematics teachers after due permissions of the various school Principals to allow the administration of the instruments. The instruments were administered under similar conditions as given by the examination bodies. The students' responses were collected immediately. The instruments were grouped as follows:

Form X (2022 WAEC May/ June) Group A
Form Y (2022 NECO June/ July) Group B

The test items responded to were scored dichotomously, using graded score "1" for right answer and "0" for wrong answer. The data were entered into Statistics Package for Social Science (SPSS) version 23 and Microsoft excel data sheets. The eirt software was used to determine the item parameters. Research questions were answered with descriptive statistics, while hypotheses were tested using independent sampled t-test statistics at 0.05 alpha level of significant.

Results

Research Question One: What are the results of linear equating of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations?

To answer this research question, the ability estimates of the students from group A (the students that answered the 2022 WAEC Mathematics questions) and group B (the students that answered the 2022 NECO Mathematics questions) were first estimated, and then the ability estimates of students that answered the 2022 WAEC Mathematics questions were placed on the same scale ability estimates of students that answered the 2022 NECO Mathematics questions through linear equating method. To achieve the equating, linear equating formula given by Kolen and Brennan (2014) was used. The formula is given by:

$\theta yi = A\theta xi + B$----------1

Where A = Slope

B = Intercept

θyi = Ability of group A students on the scale of ability of group B students

$A\theta xi$ = Ability of the students that answered the 2022 WAEC Mathematics questions

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Table 1: Summary of the Equated Scores of WAEC and NECO using Linear Equating Method

S/N	WAEC	NECO
1	31	35
2	22	22
3	39	48
4	18	16
5	20	20
6	24	24
7	34	40
8	37	45
9	41	50
10	42	52

Table 1 reveals that a score of 20, 22, and 24 in WAEC are also equivalent to the score 20, 22, and 24 in NECO. A score of 31 in WAEC is equivalent to 35 in NECO; a score of 39 in WAEC is equivalent to 48 in NECO; a score of 18 in WAEC is equivalent to 16 in NECO; a score of 34 in WAEC is equivalent to 40 in NECO; a score of 37 in WAEC is equivalent to 45 in NECO; a score of 41 in WAEC is equivalent to 50 in NECO; and a score of 42 in WAEC is equivalent to 52 in NECO. Due to these equated scores, the two public examining bodies are measuring very similar knowledge and skills on the test forms.

Research Question Two: What are the item difficulty parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations?

Table 2: Descriptive Statistics of the Item Difficulty Parameters of 2022 WAEC May/ June and NECO June/ July Mathematics Multiple Choice Teste Items

Exam Body	Mean ($\bar{X}$)	SD	Minimum	Maximum
May/June WAEC	0.61	0.20	0.21	0.91
June/July NECO	0.57	0.12	0.25	0.76

Table 2 shows the descriptive statistics of the 50-item WAEC and 60-item NECO parameters using classical test theory. From the table 2, it can be seen that difficulty indices for the 2022 WAEC and NECO Mathematics items ranged between 0.21 - 0.91, and 0.25 - 0.76 respectively. On the average, the 2022 WAEC May/June Mathematics multiple choice test items were of higher difficulty ($\bar{X}$ = 0.61, SD = 0.20) than the 2022 NECO June/July Mathematics multiple choice test items ($\bar{X}$ = 0.57, SD = 0.12).

Research Question Three: What are the item discrimination parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations?

Table 3: Descriptive Statistics of the Item Discrimination Parameters of 2022 WAEC and NECO Mathematics Multiple Choice Teste Items

Exam Body	Mean ($\bar{X}$)	SD	Minimum	Maximum
May/June WAEC	0.26	0.15	-0.09	0.53
June/July NECO	0.34	0.13	0.02	0.56

Table 3 shows the descriptive statistics of the 50-item WAEC and 60-item NECO parameters using classical test theory. From the table, it can be seen that discrimination indices for the 2022 WAEC May/June and NECO June/July Mathematics items ranged between -0.09 - 0.53, and 0.02 - 0.56 respectively. The negative discrimination index observed in NECO items is an indication that the weak examinees got difficult items right or vice versa. On the average, the 2022 NECO June/July items had higher discrimination index ($\bar{X}$ = 0.34, SD = 0.13) than the 2022 WAEC May/June items ($\bar{X}$ = 0.26, SD = 0.15). Therefore, there is a difference in the discrimination levels of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations.

Hypothesis One: There is no significant difference in the item difficulty parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations.

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Table 4: Independent Sampled t-test of the difference in the Item Difficulty Parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics Multiple Choice Examinations

Examination Body	N	Mean	Standard deviation	t	df	Sig.(p-value)
WAEC	50	0.61	1.97	-1.130	108	0.261
NECO	60	0.57	1.22			

$\alpha = 0.05$

Table 4 shows that the p-value (0.261) is greater than the alpha value (0.05), this means that there is no difference. Therefore, there is no significant difference in the item difficulty parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations.

Hypothesis Two: There is no significant difference in the item discrimination parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations.

Table 5: Independent Sampled t-Test of the difference in the Item Discrimination Parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics Multiple Choice Examinations

Examination Body	N	Mean	Standard deviation	t	df	Sig.(p-value)
WAEC	50	0.26	1.46	2.94	108	0.004
NECO	60	0.34	1.31			

$\alpha = 0.05$

Table 5 shows that the p-value (0.004) is less than the alpha value (0.05), this means that there is a difference. Therefore, there is a significant difference in the item difficulty parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations.

Discussion of Findings

The results of the research question one showed that the WAEC scores is equivalent to the NECO scores using linear equating method. The findings of this study also shows that there are closely equivalent scores in WAEC and NECO. This can be attributed to a relatively long period of operation of these two Senior School Certificate Examination bodies. The finding of this study is in agreement with the findings of Olatunji (2015), who used linear equating method to equate some of the scores obtained in WAEC and NECO, and found that the 2014 WAEC and NECO scores are equivalent.

Findings from research question two revealed that the 2022 WAEC May/June Mathematics multiple choice test items were of higher difficulty ($\bar{X}$ = 0.61, SD = 0.20) than the 2022 NECO June/July Mathematics multiple choice test items ($\bar{X}$ = 0.57, SD = 0.12). This means that WAEC have better difficulty indices than NECO. The findings of this study is in line with the findings of Thomas, Uchegbue and Ugbe (2012), who compared psychometric properties of students' 2011 WAEC and NECO Mathematics objectives test item scores, and found that the mean of difficulty parameters of the 2011 WAEC is greater than that of 2011 NECO Mathematics.

Results from research question three revealed that the 2022 NECO June/July items had higher discrimination index ($\bar{X}$ = 0.34, SD = 0.13) than the 2022 WAEC May/June items ($\bar{X}$ = 0.26, SD = 0.15). This means that the 2022 NECO Mathematics test items discriminated between the high and low ability of the students better than the WAEC. The findings of this study is not in agreement with the findings of Adekunle (2015), who found that 2008 WAEC had a discriminating power of 0.43 and higher than the 2008 NECO with a mean discriminating power of 0.39.

This study also found that there is no significant difference in the item difficulty parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations. This finding supports that of Aborisade and Fajobi (2020), and Kolawole (2017), who found that there are no significant differences in the difficulty level of WAEC and NECO multiple-choice items in Mathematics. The finding is not consistent with

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Adeniran (2000) submission that NECO is inferior to WAEC in all standards. Contrarily to the findings of the present study, Adeyemo (2019) found that there was a significant difference in the estimated difficulty index of the Ekiti State Unified Examination and the West Africa Senior Certificate Examination Mathematics items. From the result, the estimated difficulty indices of both Mathematics items were 0.4513 and 0.3124 respectively.

Furthermore, this study found that there is a significant difference in the item discrimination parameters of the 2022 WAEC May/ June and 2022 NECO June/ July Mathematics multiple choice Examinations. The finding of this study is in agreement with the findings of Adeyemo (2019), who found that the estimated discrimination indices of both examinations Mathematics items (ESUE and WASCE) were 0.2303 and 0.7381 respectively. Even though the difference between the two indices was small, there was a significant difference in the discrimination power, also, the t-test value was $t=16.664$, $df=98$, $p<0.05$.

Conclusion

The study therefore concludes that Mathematics multiple choice test items which were administered by WAEC and NECO are equivalent. The scores yielded from the two examining bodies are symmetry, confirming the fact that they are measuring the same construct; even though both the discriminating power of the two test items was significantly different. Therefore, there should be no doubt or discussion about the comparability of their results or the usability of their certificates without any reservations. Equating the scores between WAEC and NECO is crucial for ensuring fairness and equity in score interpretation, making the certificates from both examining bodies equally valid and reliable for various purposes.

Recommendations

From the conclusion, the study recommends that:

1. The examination bodies should implement quality assurance mechanisms to monitor the consistency and accuracy of discrimination level evaluation across test items. This can involve independent reviews and audits to ensure adherence to established standards.
2. To improve the validity of the tests and incorporate a variety of insightful perspectives, educators, legislators, and students, among other pertinent stakeholders, should be involved in the review and revision of the test items.
3. Testing organizations should organize a cooperative workshop with educators, psychometricians, and test developers from WAEC and NECO to harmonize test procedures and standards for item generation and discrimination level analysis.

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