DIFFERENTIAL ITEM FUNCTIONING OF 2015-2017 AGRICULTURAL SCIENCE MULTIPLE-CHOICE QUESTIONS CONDUCTED BY THE NATIONAL BUSINESS- TECHNICAL EXAMINATION BOARD

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Abstract

The study examined the differential item functioning of National Business-Technical Examinations Board (NABTEB) Agricultural Science multiple choice test items (2015-2017) in South East Zone. The study adopted Descriptive Survey research design and Ex-Post-Facto research design. Two research questions and two null hypotheses were raised and formulated respectively that guided the study. The population of the study was 10, 194 Agricultural Science students which includes 5043 males and 5151 females Agricultural Science students. Sample size of 728 Agricultural Science Senior Secondary School students (SSS III) were proportionately drawn from the 72 selected secondary schools that constituted the sample size of the study. A multi-stage sampling technique was used for the study. The instrument used for data collection was NABTEB Agricultural Science constructed in 2015-2017. The instrument was re-validated by three experts, two from Measurement and Evaluation and one from the Department of Agricultural Extension Education; all from Michael Okpara University of Agriculture, Umudike. The data obtained was analysed using Kuder Richardson Formular 20 with reliability indices of 0.76. Data obtained for the study were analyzed using the Scheuneman modified Chi-square statistic to analyse all the research questions and chi-square test statistic was employed in testing the null hypotheses. Results showed that Agricultural science multiple-choice test items used in NABTEB 2015-2017, contain test items that significantly functioned differentially for testees on the basis of gender and school location. That there was no significant difference in the percentage of the number of items that functioned differentially by gender in favour of males and those in favour of females in the 2015-2017 NABTEB Agricultural Science multiple choice test examination. It was thus recommended among others that test item writers for public examinations should be encouraged to use simple English language. This will reduce the tendency of introducing additional task into the measurement of Agricultural Science ability.

Keywords: Differential Item Functioning, National Business-Technical Examinations Board

Introduction

Agriculture is the science of making use of land to raise plants and animals. It is the basic source of human sustenance on the planet earth. Agriculture is the production of food, feed, fibre and other goods by the systematic growing and harvesting of plants and animals. Agriculture is at the heart of our daily life, vital to the economy and society. Agricultural sector plays a strategic role in the process of economic development of a country. It has already made a significant contribution to the economic prosperity of advanced countries and its role in the economic development of less developed countries especially Nigeria. Introduction of Agricultural science in the secondary school curriculum in Nigeria is a worthwhile effort geared towards adequate food security by equipping the greater percent of the youths. Agricultural Science plays vital roles in the educational sector of Nigeria especially in Veterinary Medicine, Animal Science, Crop Science, Soil Science and Geology as well as Agro-chemical and Mining industries (Iwena, 2012). Despite different strategies recommended for promoting teaching and learning Agricultural Science in secondary schools, the performance of students is not encouraging. The available evidence, however, revealed that, out of 10534 candidates who sat for the National Business-Technical Examination Board (NABTEB) examinations in Agricultural Science in 2016/2017, a total of 11, 543 candidates sat for Agricultural Science, only 11% had credit level pass respectively (State Statistics Unit of National Business-Technical Examination Board, Umuahia, 2017).

National Business and Technical Examination Board (NABTEB) in Nigeria was established in 1992 through ACT 70 of 1993; its headquarters is in Benin City, Edo State. NABTEB was primarily established to take over the conduct of technical and business examinations hitherto conducted by the foreign examination bodies and the West African Examinations Council. This was to domesticate the foreign examinations and tailor them towards societal needs; and in the case of WAEC to reduce pressure on it to make it very effective (FRN, 2013).

In education, an examination is the instrument that determines the knowledge and ability of a student. Nkwocha (2015) define examination as a formal test of knowledge or ability. On the other hand, testing is an attempt to measure persons' knowledge, intelligence or other characteristics in a systematic way. According to Joshua (2012), a testis an instrument for systematic measure of a sample of behavior. Tests are used in promotion, placement, selection, certification and decision making.

A good measuring instrument measures what is supposed to measures to a high degree, consistently and with a minimum expenditure of time, energy and money (Brian, Daniel, & William, 2007). Measuring instrument includes the major desirable characteristics of validity (the extent to which an instrument measures what it is supposed to measure), reliability (the consistency of a measuring instrument), and usability (the adequacy of an instrument in terms of a minimum of time, energy, and money). A good measuring instruments posses' three qualities, which include: validity, reliability and usability (Ihechu, 2019).

Differential item functioning (DIF) is a statistical characteristics of an item that shows the extent to which the item might be measuring different abilities for members of separate sub-groups. Shephard, Camilli and Averill (2011) stated that DIF specify whether individuals of equal ability have the same probability of getting a given item correct. For the purpose of this study DIF is when a test item measures items for individuals from different sub groups of the population of test takers with the same subject matter ability. It arises from a test item that presents task outside the subject matter. A test with differentially item functioning can be described as an invalid test. If two groups exhibit differences in the probability of answering some of the items of the test correctly due to differences in English proficiency, the items can be said to present DIF. If some items function unfavorably over specific groups, the interpretations made from the test cannot be thought of as valid and fair (Ihechu, 2019). DIF may be divided into two types; uniform DIF and non-uniform DIF. Uniform DIF means that the correct response probability for one group is uniformly greater than that of the other group across all ability levels. Thus, uniform DIF exhibits when there is no interaction between the level of ability and group membership. Non-uniform DIF occurs when interaction between ability and group membership is checked. That is, non-uniform DIF means that the probability of getting items right for two groups does not follow a consistent pattern across all levels of ability (Swaminathan & Rogers, 2010).

Differential item functioning is an item characteristic that occurs whenever groups differ noticeably in their correct answer frequency and when achievement level is matched. It may be used as part of the process to identify biased items, but is almost always viewed as secondary to a sensitivity review. Because of its statistical nature, the researchers find out that many items that are identified as having DIF were not identified as having any difficulty in the sensitivity review (Hauser, Kingsbury, and Northwest Evaluation Association, 2004). Ling and Lau (2004) investigated the gender DIF in multiple choice and open- response science item types for elementary, middle and high school levels and found out that the indicative of possible sources of DIF is due to the differences in content category, visual-spatial component and item type dimensions. Adebule (2013) revealed that out of the 40 items examined for the first factor program structure in computer science, only seven items representing 17.5% displayed DIF, comparing male and female examinees. Birjandi and Mohadeseh (2007) reported that in the general reading comprehension, 7 out of the 13 DIF flagged items favoured females and 6 proved much easier for males. However, Kalaycioglu and Berberoglu (2011) and Robin, Zenisky and Hambleton (2003) who detected DIF on some items favoured males' students over females in some items. Gender is the range of physical, mental, and behavioral characteristics pertaining to, and differentiating between, masculinity and femininity. Okeke (2016) described gender as socially or culturally constructed characteristic, qualities, behaviours and roles which different societies ascribe to female and males. According to Lee (2011), gender is ascribed attribute that differentiates feminine from masculine. Therefore, with the introduction of differential item functioning in

the Technical Examination Board in Agricultural Science multiple choice item validation process, it is expected that male and female students will respond to the test item equally irrespective of their groups. Thus, the call for the for the detection of DIF in order to maintain valid assessment items for proper decision making in Nigeria especially, South East State is ideal.

Schools may be located in one of two clearly distinct socio-economic and physical environments namely; urban and rural environments (Okonkwo, 2012). Rural areas are those areas that are away from the local government headquarters, and lacking major amenities, health centres and pipe borne water. On the other hand, urban areas depict areas within the local government headquarters with key amenities. Okonkwo (2012) characterized rural society as one with low population density, less social differentiation, less social and spatial changes, Agriculture as the major occupation and which centers on the political-economic system of land holding. School location may have huge effect on the students' performance. The learning environment could be a strong determinant of scholastic performance. This is because some interplay does exist between the learning process and the learning environment which is directly related to the location of the school. According to Zumbo and Gelin (2005) school location has an impact on differential item functioning. Meanwhile, Pae (2014) reported that DIF items and school location differences in item selection on any measure that is used for a similar purpose should be considered. Felder, Mohr, Dietz and Ward (2014) found out that urban student enjoy greater success than rural student. Lee and McIntire, (2002) revealed that there is no significant difference between performance of rural students and urban students. This implies that items used in assessing student ability has element of biasness that disadvantaged the rural school examinees and favors the urban schools examinees. In the contrary Mokobi and Adedoyin (2014) in their study revealed the existence of school location biasness in mathematics examination was shifted towards the students who attended schools rural areas. Therefore, with the introduction of differential item functioning in the National Examination Council and National Business and Technical Examination Board in Agricultural Science multiple choice item validation process, it is expected that urban and rural based school students have responded to the test item equally irrespective of their groups. Thus, the call for the detection of DIF in order to maintain valid test items for proper decision making in Nigeria especially, South East Zone. There is the need for the researchers to identify DIF in test items used in measurement of Achievement in Agricultural Science. This study therefore, assesses test items that are biased in respect to gender and school location in Agricultural Science of National Business and Technical Examinations Board multiple choice test items for 2015-2017 in South East, Nigeria.

The purpose of the study was to assess test items that are biased in respect to gender and school location in Agricultural Science of National Business and Technical Examinations Board multiple choice test items for 2015-2017 in South East, Nigeria. Specifically, the study sought to find out:

1 the percentage of items in the 2015-2017NABTEB Agricultural Science multiple choice test items functioned differentially by gender.
2 the percentage of items in the 2015-2017NABTEB Agricultural Science multiple choice test items functioned differentially by school location.

Research Questions

The study sought to provide answers to the following research questions.

3 What percentage of items in the 2015-2017NABTEB Agricultural Science multiple choice test items functioned differentially by gender?
4 What percentage of items in the 2015-2017NABTEB Agricultural Science multiple choice test items functioned differentially by school location?

Hypotheses

The following hypotheses were formulated to guide the study

1. There is no significant difference between male and female students on the percentage of items which functioned differentially in the 2015-2017 NABTEB Agricultural Science multiple choice test examination.
2. There is no significant difference between urban and rural students on the percentage of items which functioned differentially in the 2015-2017 NABTEB Agricultural Science multiple choice test examination.

Methodology

The study adopted Descriptive Survey research design and Ex-Post-Facto research design. The population of the study is 10, 194 Agricultural Science students which includes 5043 males and 5151 females. A multi-stage sampling technique was used for the study. Based on Krejcie and Morgan's (1971) formula for determining sample size from a known population, a total sample size of 728 Agricultural Science Senior Secondary School students (SSS III) were proportionately drawn from the 72 selected secondary schools that constituted the sample size of the study. This consists of 325 private secondary school Agricultural Science students and 403 public secondary schools Agricultural Science students from Abia, Enugu and Imo state. A multi-stage sampling technique was used for the study. The instrument used for data collection was NABTEB Agricultural Science multiple choice test items (paper 1) conducted in 2015-2017 academic sessions. The instrument was re-validated by three experts, two from Measurement and Evaluation and one from the Department of Agricultural Extension Education; all from Michael Okpara University of Agriculture, Umudike. The instrument was administered once in the area that was not part of the sample. The data obtained was analysed using Kuder Richardson Formular 20 with reliability indices of 0.76. Data obtained for the study were analyzed using the Scheuneman modified Chi-square statistic to answer all the research questions and chi-square test statistic was employed in testing the null hypotheses at 0.05 level of significant.

Results

The alphabet on Chi-square value of DIF reflected the group of gender favoured. It was obtained by attaching alphabet f to DIF in favour of females and alphabet m if the item revealed DIF in favour of the males, only when the Chi-square value was greater than 9.49 critical values. Also, the alphabet on Chi-square value of DIF reflected the group of school location favoured. It was obtained by attaching alphabet r to DIF in favour of rural and alphabet u if the item revealed DIF in favour of the urban, only when the Chi-squarevalue was greater than 9.49 critical values.

Research Question One: What percentage of items in the 2015-2017NABTEB Agricultural Science multiple choice test items functioned differentially by gender?

Table 1: Scheuneman Chi-square Gender Differential Item Functioning Indices for May/June NABTEB Agricultural Science Multiple Choice Test Items used in 2015, 2016 and 2017 respectively

ITEMS	2015 x^2	2016 x^2	2017 x^2
1	14.51**$_m$	3.65	7.23
2	3.42	5.36	2.53
3	1.49	4.34	.98
4	4.21	3.55	13.98**$_m$
5	3.63	10.54*$_f$	4.34
6	0.54	5.45	2.34
7	1.37	1.43	2.67
8	2.43	4.34	2.56
9	1.35	3.43	6.45
10	5.36	2.54	6.45
11	4.14	2.42	5.12
12	4.46	4.22	5.12
13	15.34 **$_m$	3.22	2.34
14	3.91	8.53	10.43 *$_f$
15	2.74	6.52	7.58
16	4.61	5.67	4.66
17	3.77	7.34	11.45* $_m$
18	2.37	6.22	6.09
19	5.74	6.21	10.17 *$_f$
20	3.54	5.65	3.56
21	4.24	6.54	5.45
22	10.82* $_m$	11.22*$_m$	2.45
23	3.12	3.17	2.23
24	6.12	2.35	3.67
25	2.34	1.23	2.22
26	2.61	.78	3.45
27	15.52** $_f$	4.22	12.22*$_m$
28	2.61	5.39	5.43
29	5.31	4.37	1.45
30	4.67	15.60**$_m$	3.54
31	3.52	3.60	2.45
32	10.12* $_m$	4.87	5.43
33	3.45	2.49	3.34
34	4.34	5.21	23.45
35	5.21	2.37	5.56
36	10.14* $_f$	4.16	4.43
37	5.32	4.61	3.12
38	3.25	3.34	2.45
39	4.25	3.42	11.32*$_m$
40	6.18	4.23	10.33*$_m$
41	12.16* $_f$	10.01 *$_m$	4.21
42	10.32* $_f$	1.19	2.22
43	6.32	15.28** $_f$	5.22
44	5.13	2.46	2.17
45	16.31 **$_m$	2.32	3.33
46	2.43	2.14	2.12
47	15.13** $_m$	.84	.84
48	3.13	3.14	3.12
49	4.12	16.24 **$_f$	3.43
50	5.15	2.64	3.60

** or * significant at the 0.05 level, df = 4 critical x^2 = 9.49

From Table 1, it can be seen that ten items representing 20% in 2015 NABTEB Agricultural Science multiple choice test items significantly function differentially for testees on the basis of gender, while six items representing 12% significantly function differently for testees on the basis of gender in similar test used in 2016 examination and seven items representing 14% in 2017functioned differentially by gender. The above result shows that NABTEB Agricultural Science multiple-choice test items used in 2015-2017 examinations contain test items that significantly functioned differentially for testees on the basis of gender.

Generally, the Scheuneman modified Chi-square comparing NABTEB 2015-2017 Agricultural Science multiple-choice test items for female and male flagged 23 items with significantly differential item functioning ($p < .05$). It was revealed that, 14 items out of 23 items representing 61% in NABTEB 2015-2017, that displayed DIF favoured male while 9 items out of 23 items representing 39% were in favour of female.

A corresponding hypothesis formulated to further address the research question is:

Hypothesis One: There is no significant difference between male and female students on the percentage of items which functioned differentially in the 2015-2017 NABTEB Agricultural Science multiple choice test examination.

Table 2: Chi-square Summary of 2015-2017 NABTEB Agricultural Science Differential Items Functioning.

Gender	Percentage	Item favoured due to DIF	Df	Chi-square	Sig.(2-tailed)
Male	61	14(11.5)			
Female	39	9(11.5)	1	1.087	0.516
Total	100	23			

χ^2 tabulated at 0.05 level of significant with 1 df = 3.84

Data in Table 2 shows that the chi-square calculated value of 1.087 is less than the tabulated chi-square value of 3.84 when tested at 0.05 level of significance with 1 degree of freedom. Therefore, the null hypothesis which states that 'there is no significant difference between male and female students on the percentage of items which functioned differentially in the 2015-2017 NABTEB Agricultural Science multiple choice test examination is thereby upheld. It implies that there is no significant difference between male and female students on the percentage of items which functioned differentially in the 2015-2017 NABTEB Agricultural Science multiple choice test examination.

Research Question Two: What percentage of items in the 2015-2017NABTEB Agricultural Science multiple choice test items functioned differentially by school location?

Table 3: Scheuneman Chi-square School Location Differential Item Functioning Indices for May/June NABTEB Agricultural Science Multiple Choice Test Items used in 2015, 2016 and 2017 respectively

ITEMS	2015 x^2	2016 x^2	2017 x^2
1	13.25*$_r$	3.15	3.23
2	8.18	12.91*$_u$	3.47
3	2.47	2.63	2.67
4	11.85*$_r$	3.52	5.98
5	15.73**$_u$	4.83	17.31**$_u$
6	3.12	5.77	4.33
7	4.56	16.36**$_u$	8.23
8	1.71	1.75	1.74
9	3.10	11.38*$_u$	1.55
10	4.16	3.84	11.99*$_u$
11	9.89*$_r$	17.56**$_u$	5.91
12	5.12	10.90*$_r$	5.41
13	18.60**$_u$	3.66	3.45
14	3.13	3.80	3.82
15	15.81**$_u$	3.86	4.18
16	8.55	4.38	6.72
17	10.45*$_r$	4.33	4.65
18	2.85	3.79	16.96**$_u$
19	3.66	5.92	16.32**$_u$
20	6.65	3.41	4.22
21	12.48*$_r$	3.68	13.50**$_u$
22	18.23**$_u$	5.47	3.27
23	13.70*$_u$	4.33	5.93
24	5.54	3.71	8.24
25	8.33	13.42*$_r$	3.58
26	17.43**$_u$	5.17	10.01*$_u$
27	8.12	4.73	6.63
28	19.42**$_r$	6.24	5.35
29	10.98*$_u$	17.05**$_u$	11.34 *$_r$
30	6.19	4.93	4.79
31	3.16	13.38*$_r$	6.42
32	7.35	6.48	6.18
33	11.14*$_r$	3.17	8.13
34	12.26*$_u$	13.08*$_u$	2.43
35	8.28	.89	15.38**$_u$
36	10.88*$_r$	6.83	8.13
37	5.45	3.17	3.07
38	6.71	5.16	6.35
39	4.54	7.75	11.15*$_u$
40	19.15**$_u$	4.79	5.64
41	16.13**$_u$	4.87	3.05
42	8.54	10.39*$_r$	2.07
43	8.30	2.70	3.56
44	11.96*$_r$	17.54**$_u$	1.25
45	5.67	4.46	11.77*$_u$
46	17.69**$_u$	3.14	1.56
47	3.06	18.25**$_u$	4.44
48	10.50*$_r$	6.67	2.70
49	4.96	14.96*$_u$	5.19
50	15.52**$_u$	5.54	17.52**$_u$

** or * significant at the 0.05 level, df = 4 critical x^2 = 9.49

Data in Table 3 revealed that a total of 22 test items representing 44% of Agricultural Science multiple choice test items used in NABTEB examination in 2015 differentially functioned for candidates from urban and rural areas. In 2016 examination, 13 items representing 26% showed evidence of differential item functioning for testees from urban and rural areas, while 11 items representing 22% showed evidence of differential item functioning for testees from urban and rural areas in 2017. The above result shows that Agricultural Science multiple-choice test items used in NABTEB 2015-2017, contain test items that significantly functioned differentially for testees on the basis of school location.

Generally, the Scheuneman modified Chi-square comparing NABTEB 2015-2017 Agricultural Science multiple-choice test items for rural and urban flagged 46 items with significantly differential item functioning ($p < .05$). It was revealed that, 15 items out of 46 items representing 33% in NABTEB 2015-2017, that displayed DIF favoured students in rural areas while 31 items out of 46 items representing 67% were in favour of students in urban areas.
A corresponding hypothesis formulated to further address the research question is:

Hypothesis Two: There is no significant difference between urban and rural students on the percentage of items which functioned differentially in the 2015-2017 NABTEB Agricultural Science multiple choice test examination.

Table 4: Chi-square Summary of 2015-2017 NABTEB Agricultural Science Differential Items Functioning in Favour of Rural and Urban Students.

School location	Percentage	Item favoured due to DIF	Df	Chi-square	Sig.(2-tailed)
Rural	33	15(23)			
Urban	67	31(23)	1	5.565	0.005
Total	100	46			

χ^2 tabulated at 0.05 level of significant with 1 df = 3.84

Data in Table 4 shows that the chi-square calculated value of 5.565 is greater than the tabulated chi-square value of 3.84 when tested at 0.05 level of significance with 1 degree of freedom. Therefore, the null hypothesis which states that 'there is no significant difference between urban and rural students on the percentage of items which functioned differentially in the 2015-2017 NABTEB Agricultural Science multiple choice test examination is thereby rejected. It implies that there was a

significant difference between urban and rural students on the percentage of items which functioned differentially in the 2015-2017 NABTEB Agricultural Science multiple choice test examination.

Discussion of Findings

The findings showed that Agricultural Science multiple-choice test items used in NABTEB 2015-2017 contain test items that significantly functioned differentially for testees on the basis of gender. It was revealed that, 14 items out of 23 items representing 61% in NABTEB 2015-2017, that displayed DIF favoured male while 9 items out of 23 items representing 39% were in favour of female. The correspondent hypothesis affirmed that there is no significant difference between the male and female students on the percentage of items which functioned differentially in the 2015-2017 NABTEB Agricultural Science multiple choice test examination. The finding agreed with that of Adebule (2013) that out of the 40 items examined for the first factor program structure in computer science, only seven items representing 17.5% displayed DIF, comparing male and female examinees. The finding is also in agreement with the report of Birjandi and Mohadeseh (2007) that in the general reading comprehension, 7 out of the 13 DIF flagged items favoured females and 6 proved much easier for males. The findings were in line with those of Kalaycioglu and Berberoglu (2011) and Robin, Zenisky and Hambleton (2003) who detected DIF on some items favoured males' students over females in some items.

The findings in Table 3 and 4showedthat Agricultural Science multiple-choice test items used in NABTEB 2015-2017, contain test items that significantly functioned differentially for testees on the basis of school location. It was revealed that, 15 items out of 46 items representing 33% in NABTEB 2015-2017, that displayed DIF favoured students in rural areas while 31 items out of 46 items representing 67% were in favour of students in urban areas.. The correspondent hypothesis affirmed that there was a significant difference between the urban and rural students on the percentage of items which functioned differentially in the 2015-2017 NABTEB Agricultural Science multiple choice test examination. The finding of this study agrees with the finding of Felder, Mohr, Dietz and Ward (2014) who find out that urban student enjoy greater success than rural students. The findings of this study agree with Lee and McIntire, (2002) whose findings revealed that there is no significant difference between performance of rural students and urban students. This implies that items used in assessing student ability have elements of bias that disadvantaged the rural school examinees and favoured the urban schools examinees. In the contrary Mokobi and Adedoyin (2014) in their study revealed the existence of location biasness in mathematics examination was shifted towards the students who attended schools in rural areas. So, in effect, there is no hard and fast rule about the influence of location. This notwithstanding, there is still need to maintain non-bias in test items.

Conclusion

The study investigated the Differential Item Functioning of National Business and Technical Examinations Board (NABTEB) Agricultural Science multiple choice test items (2015-2017) in South East Zone of Nigeria. From the finding, it was concluded that Agricultural Science multiple-choice test items constructed by NABTEB and used in 2015-2017, contain test items that significantly functioned differentially for testees on the basis of gender. Such items measured different things for testees of the same subject matter ability from male and female testees.

It was also concluded from the finding that school type was the greatest influence on differential item functioning. It was also concluded that that there is no significant difference in the percentage of the number of items functioned differentially by gender in favour of males and those in favour of females in the 2015-2017 NABTEB Agricultural Science multiple choice test examination, that significant difference exist in the percentage of the number of items functioned differentially by school location in favour of rural and those in favour of urban in the 2015-2017 NABTEB Agricultural Science multiple choice test examination. Therefore, test developers, ministry of education and examination bodies should ensure that items are free from differential item functioning (DIF).

Recommendations

On the basis of the findings and conclusion, the following recommendations are made:

I. Test item writers for public examinations should be encouraged to use simple English language. This will reduce the tendency of introducing additional task into the measurement of Agricultural Science ability.

ii. Test experts and developers should consider the use of Scheuneman modified chi-square in determining differential item functioning. This approach provides an intuitive and flexible methodology for detecting DIF.

iii. For bias-free items to be produced, the NABTEB examination test developers should make certain that activities and connotations reflected in the test are relevant to the life experiences of examinees responding to the items.

iv. NABTEB and other public examination bodies should analyse students' response to test items for differential functioning before building the test.

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