

## Detection of Item Bias in Mathematics Multiple Choice Test Items of West African Examination Council in Enugu State using Differential Item Functioning Technique.

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**ABSTRACT:** *The study investigated the presence of Differential Item Functioning (DIF) by gender in West African Examinations Council (WAEC) 2021 Mathematics Multiple Choice Test Items in Enugu State. An Expose Factor research design was employed. A sample of 1,585 candidates was used. The candidates' population by gender showed that males have the population of 687 while the females are 898. A 50-item multiple choice Mathematics test item was used to gather data. To detect the items that functioned differentially by male and female test takers, Mantel-Haenszel statistical method, which is one of the methods of DIF detection was applied. The results of the analysis revealed that, 7 items in favour of males and 4 items in favour of females, (22%) of the 50 test items set and administered by WAEC 2021 exhibited significant differential item functioning by gender. Based on the findings, the study concluded that the items used by WAEC in the above examinations were bias by gender. Hence, the study recommended that WAEC and other examination bodies should ensure that the items are fair to test takers of all subgroups and be able to assess only knowledge and skills that are identified as part of the domain being tested.*

**Keywords:** *bias in external examinations, mathematics, students, gender, interest, innovation*

### Introduction

Education as the fulcrum for national development and a systematic all-round development of individuals as they fit into society is considered a priority sector in every well meaning society. Arogundade and Belo (2019) defined education as the most important weapon used to produce a total person with the appropriate skills, knowledge, attitude and values required to live a fulfilled life. Chakraborty (2022) extols education as one of the most powerful tools for transforming the whole nation into a digitally empowered society and knowledge economy. Education, therefore, can be said to be a major force in economic, intellectual, social and cultural empowerment. Its essence is highly

treasured as it brings about character and attitudinal changes, and as well has the ability to reshape human potentials for desired development. It can enable its possessors with qualitative creativity and skills for qualitative decision making while responding to both the local and global challenges.

The importance of education has been well accentuated in all societies whether ancient or modern, developed or developing. This obvious necessity has led very many countries to accord great emphasis to education both in terms of quality and access. In Nigeria, education is an excellent instrument for effective national development (Federal Republic of Nigeria, FRN, 2014). Thus, the Federal Government

of Nigeria formulated the National Policy on Education to eradicate illiteracy at all levels of human existence and provide affordable education for all Nigerians irrespective of class, religion or ethnic origin. This policy was driven by a desire to eradicate poverty, increase political consciousness and encourage issues of national integration. The foremost law on education in Nigeria is in the 1999 Constitution of the Federal Republic of Nigeria (CFRN). This constitutional provision however, implies that the government is not obligated to provide these rights as stated below, where it is deemed impracticable to do so. The constitution provides as its educational objectives the following: “Government shall direct its policy towards ensuring that there are equal and adequate educational opportunities at all levels. Government shall promote science and technology. Government shall strive to eradicate illiteracy; and to this end, Government shall as and when practicable, provide: (a) free, compulsory and universal primary education; (b) free secondary education; (c) free university education; and (d) free adult literacy programme (CFRN Const. Chap. II, § 18)”.

In pursuance of the objectives of the National Policy on Education, Nigerian government has, from time to time, introduced different educational reform programmes. The motives could differ, but it is believed that each new one is an improvement on the former one. The constant deepening of learning abilities and creativities of citizens has always called for regular update of our educational system. Experts in the field have always encouraged the government to conscientiously assess the current status of learning in the country at three years intervals to ensure constant update with the rest of the world and for the avoidance of biases and destructive differentials. The school environment is the

battle ground for the testing and improvement of learning.

School is one of the social institutions that is responsible for the development and training of the mind and skill of man. It helps to prepare man for the challenges and responsibilities in the society at large. Thus, the role of secondary school in national educational system cannot be overemphasized. One can define secondary school as the intermediary level between the primary and tertiary education. It stands as a midpoint in the pecking order of education, whose quality predicts and tends to influence the standard of tertiary education and the level of literacy in the country. As the intermediary school, secondary education absorbs the products of primary education and serves as an input unit for tertiary education.

The trend in the academic achievement of secondary school students in Nigeria in the recent years has become a major source of concern to all stakeholders in the educational sector. Nwadinigu and Azuka (2012) observed that the current records of students’ performances are glaring evidence that many Nigerian students are performing below expectation in their academics when left alone. For them, there is mass decline in the achievement of students especially in SSCE mathematics in WAEC. Adesemowo (2016), further stressed in his explanation that the annual release of senior secondary certificate examination conducted by West African Examination Council (WAEC) depicts the problematic nature and generalization of poor secondary school students’ achievement in different school subjects especially Mathematics and English language. Nwadinigu and Azuka predicted that the poor performances could be as a result of several factors such as poor teaching, psychological factors, unpreparedness on the part of the students, poor learning environment, location of

schools and the evaluation process. Mathematics is gradually fading and going into oblivion among students.

Mathematics, being the chief cornerstone in the sciences, requires absolute measures to regain improvement due to its importance in nation building. Igbokwe, (2013), stressed that without mathematics there will be no technology and without technology there will be no modern society. This implies that a strong background in mathematics is critical for the nation's development. It is not surprising therefore that the interest of WAEC, mathematics' teachers, educationists, parents and government are focused on finding solution to the problems that militate against the teaching and learning of mathematics in secondary schools. Many other researchers abound on this. For Pascarella and Terenzini (2019), the students' academic performance depends greatly to the school environment. He agreed that socialization patterns in Nigeria and most African setting place enormous restrictions on the female gender and from her a higher input of daily domestic labour than from the male counterpart. This perception automatically schemes female out from any consideration for serious professional discipline even in cases where the female appears to be more brilliant than their male counterpart.

These discoveries show that the influence of gender has not been stabled on students' academic achievement. The above challenges posit the consequence that the quality of education may not be even; and the national policy of education for a democratic, egalitarian society cannot be attained unsentimentally. This calls for continuous verification of the influence of gender on students' academic achievement in mathematics from different locations and from time to time to ensure fairness and equality of access to education among citizens. To effectively achieve this,

educationists have continuously advocate for regular assessment of students' academic abilities.

Assessment of learning outcomes using test is a basic issue in our education system. This is because; test may include items that operate differently for certain groups, thereby resulting to item bias. But testing has been fully accepted in most modern societies as the most objective method of decision making in schools, industries and government establishments. It, therefore, becomes imperative to build an important step in the construction of assessment instruments to ensure that no individual or group responding to the instrument is disadvantaged in any way. Thus, the researcher sees the existence of bias in an item as an issue that needs to be addressed to ensure fairness of test items for every test taker since tests are used as a gatekeeper for educational opportunities.

Test fairness is a crucial issue in testing; it reflects the same constructs for all test takers and scores have the same meaning for all individuals in the intended population. There is need to ensure that items are not only valid and reliable but also fair to all across the subgroups of test takers. It can be said that fairness of test items is any test given to a set of test takers with equal chance to demonstrate what they know. It is crucial then that test takers of the same latent trait should respond to test items uniformly irrespective of their gender. Fair test is a test that enables all examinees to have an equal chance to demonstrate the skills and knowledge which they have acquired and which are vital to the purpose of the test. Thus, the National Policy on Education stated that national examinations tests should be valid and fair to all students to which the test is set to measure the attributes that is needed from them.

Test items are said to be bias if they function differently for a specified subgroup of test takers. Bias, on the other hand, is the existence of some irrelevant elements present in items that cause differential performance for individuals of the same ability but are either from different gender or location of schools attended. They are considered biased because they contain sources of difficulty that are not relevant to the construct being measured and these extraneous sources affect test takers' performances. Bias tests items measure characteristics that are not necessary or items that are irrelevant to the tests.

Item bias and differential item functioning (DIF) can be said to have critical political, social and ethical implication for test developers, policy makers and test takers. Penfield & Camilli (2007) states that differential item functioning exists in a test item when, despite controls for overall test performance, the test takers from different groups have a different probability of getting an item correctly or when students from two sub-populations with the same ability level have different expected scores on the same item. This implies that if some items function unfavorably over specific groups, the explanations made from the test cannot be thought of as valid and fair. Differential item functioning (DIF) is an approach that is widely used to find out items that are bias. It refers to differences in the statistical properties of an item between groups of equal ability. It is the probability of success on an item of examinees of the same ability but belonging to different groups. It is a statistically technique that is used to identify differential item response patterns between groups of examinees which helps in verifying potentially biased test items. Any item indicating differential item functioning is imperatively bias if and only if the source of variance is not relevant to the construct being measured by the test. Therefore, the researcher is optimistic that the study of

item bias and DIF would help to provide an empirical foundation for the identification and subsequent elimination of test items that appear to be relatively more difficult for one group of test takers than another in every external examination.

External examinations are conducted by or on behalf of the state or nation and they are open to all those who meet certain defined entry criteria. West Africa Examination Council (WAEC) and National Examination Council (NECO) conduct Senior School Certificate Examination (SSCE) at the completion of Senior Secondary School to determine the extent of knowledge acquired by test takers during their secondary school program, as a pre-requisite for admission into tertiary institutions. Nwadinigu and Azuka gave out the following qualities as inalienable for any examination to be adjudged good: (i). examination questions and marking schemes should produce scores that are both reliable and valid. (ii). The conduct of the examination and the published results should be deemed fair and achieve a high level of acceptance by the public. (iii). The examination should ensure that no particular candidate or group of candidates has an unfair advantage over others. This is in consonance with the researcher's effort which is detecting the possible differential item functioning (DIF) in mathematics items in 2021 WAEC examination.

The position mathematics occupy in the National Policy on Education (FRN) and its role towards technological and industrial development put mathematics in a special place in various ladders of education; primary, secondary and tertiary levels. Mathematics is made up of a set of concepts, facts, principles, and operations that are fundamental to the existence of every individual man. It is a science of quantity and space, the corner stone of every field of education. It is a science and a way of

thinking that has rules, goals and players just like a game. Its learning calls for imagination, participation and skills. The mathematics concept is broad in the senior secondary school. Learners are expected to learn these basic mathematics concepts that are fundamental to their achievements in the subject. The learners' mastery of these concepts and principles are assessed through tests as in multiple choice questions. These must be properly represented in the questions for the avoidance of bias that will culminate into Differential Item functioning DIF in mathematics achievement test. Thus, the researcher investigated if the multiple choice Mathematics test items administered by WAEC 2021 function differentially by gender.

### **Statement of the Problem**

The knowledge of mathematics can facilitate nation building and industrialization. Every scientific innovation and technological advancement has mathematics as bedrock. Therefore, mathematics is supposed to be availed to all students fairly and without bias to enable them have equal access and opportunity to contribute to nation building and development. Males as well as females can greatly bring about the transformative effects of scientific development in our dear country, Nigeria. To rely majorly on males for any scientific transformation of our country could retard any scientific advancement in it. It is of vital importance that both males and females are given equal opportunities in the task of scientific innovation in the country. And if this is to be so, the study of mathematics in our country should consider those areas where females are blindfolded but are open to males. Thus, the researcher used the differential item functioning techniques to detecting those items in the multiple choice mathematics questions that favour males more in the WAEC 2021.

The main purpose of this study is to detect item bias in mathematics multiple choice test administered by WAEC 2021 using differential item functioning. That is, the researcher inquired if WAEC 2021 test items in mathematics multiple choice test function differentially in terms of gender (male and female). The data analysis was carried out using R (R core Team, 2022) while Dif R package was used to perform differential item functioning analysis. The research questions were answered using Mantel-Haenszel common odds ratios deltaMH on delta scale. The 3 detection methods of M-H procedure, R and dif R show that there is a slight significant different in the functionality of gender in the WAEC examination.

The significance of this study will go a long way to eliminating bias in any test by the exam bodies like WAEC, NECO and others: through proper evaluation, the test developers will be able to construct items that appropriately measure test takers' knowledge of the test items. That is, the items will only portray the differential status of students of urban versus students of rural test takers when exposed to answering WAEC Mathematics multiple choice items in achievement test. This will enable all test takers irrespective of locations have equal measure and opportunity to study significant science courses in the university.

### **Research Question**

The following research question guided the study: Which of the items in WAEC 2021 mathematics multiple choice test exhibit differential item function among male and female test takers? The following hypotheses were tested at the 0.05 level of significance:  $H_{01}$ . Items in the mathematics multiple choice test set and administered by WAEC 2021 do not significantly function differentially among test takers on gender bases.

## Results

The results are presented in table 1 and 2 in line with the research question and null hypothesis that guided the study below.

### Research Question One:

Which of the items in WAEC 2021 Mathematics multiple choice test exhibit Differential Item Functioning among male and female test takers?

**Table 1: Effect Sizes (deltaMH) of Differential Item Functioning of WAEC 2021 Mathematics Multiple Choice Test Based on Gender.**

| Items | alphaMH | deltaMH | Remark |
|-------|---------|---------|--------|
| 1     | 0.47    | -1.77   | C      |
| 2     | 0.23    | -2.11   | C      |
| 3     | 1.65    | -3.21   | C      |
| 4     | 0.00    | 1.81    | C      |
| 5     | 1.71    | -3.57   | C      |
| 6     | 2.79    | 2.45    | C      |
| 7     | 0.00    | 1.77    | C      |
| 8     | 1.65    | 2.09    | C      |
| 9     | 0.00    | 1.91    | C      |
| 10    | 0.00    | 2.78    | C      |
| 11    | 0.00    | 1.50    | C      |
| 12    | 0.56    | 1.79    | C      |
| 13    | 0.70    | 2.77    | C      |
| 14    | 0.60    | 1.67    | C      |
| 15    | 0.00    | 2.77    | C      |
| 16    | 3.50    | -2.35   | C      |
| 17    | 3.12    | -3.79   | C      |
| 18    | 2.09    | -1.67   | C      |
| 19    | 1.10    | -1.71   | C      |
| 20    | 3.09    | 1.90    | C      |
| 21    | 2.11    | -1.54   | C      |
| 22    | 3.89    | -3.78   | C      |
| 23    | 0.77    | 2.89    | C      |
| 24    | 0.00    | 3.87    | C      |
| 25    | 0.00    | 2.91    | C      |
| 26    | 0.44    | 1.91    | C      |
| 27    | 0.00    | 1.79    | C      |
| 28    | 0.00    | 3.12    | C      |
| 29    | 0.41    | -2.09   | C      |
| 30    | 0.00    | 2.32    | C      |
| 31    | 0.00    | 2.79    | C      |
| 32    | 0.50    | 1.63    | C      |
| 33    | 0.98    | 1.89    | C      |
| 34    | 0.56    | 1.91    | C      |

|    |      |       |   |
|----|------|-------|---|
| 35 | 1.84 | -1.85 | C |
| 36 | 0.00 | 3.54  | C |
| 37 | 0.00 | 2.99  | C |
| 38 | 0.24 | 3.35  | C |
| 39 | 0.00 | 2.11  | C |
| 40 | 0.64 | 1.04  | B |
| 41 | 0.28 | 2.98  | C |
| 42 | 0.00 | 2.20  | C |
| 43 | 0.00 | 1.65  | C |
| 44 | 0.64 | 1.04  | B |
| 45 | 0.00 | 1.90  | C |
| 46 | 1.33 | -0.68 | A |
| 47 | 1.33 | -0.68 | A |
| 48 | 2.09 | -1.76 | C |
| 49 | 0.00 | 2.11  | C |
| 50 | 1.33 | -0.68 | A |

Effect size code: 'A': negligible effect; 'B': moderate effect  
 'C':large effect; Effect size codes:0 'A' 1.0 'B' 1.5 'C'  
 (for absolute values of 'deltaMH')

Table 1 shows that items 2, 3,5,16, 18, 19, 21, 22, 29,35,46,47,48, and 50 with minus signs (-) are differentially more difficulty for the focal group (male students) while the remaining items are differentially easier for the focal group (male students). Table 1 shows the deltaMH statistic which measures the magnitude of differential item functioning exhibited by the WAEC 2021 Mathematics multiple choice test with respect to male and female test takers. Three of the 50 items (47, 48 and 50) have absolute Mantel-Haenszel values below1.0 which indicates no differential item functioning. Two of the items (40 and 44)

have absolute Mantel-Haenszel values ranging from 1.00 to 1.40 which indicate weak differential item functioning. The remaining 45 items representing 90% of the 50 items have absolute Mantel-Haenszel values greater than 1.50, which indicate large differential item functioning. It appears that the magnitude of large differential item functioning is significant.

#### **Hypothesis One:**

Items in the Mathematics multiple choice test set and administered by WAEC 2021 do not significantly function differently among test takers on gender bases.

**Table 2: Mantel-Haenszel Chi-Square Statistic Analysis of DIF of WAEC 2021 Mathematics Multiple Choice Test.**

| Item  | Stat. | P-value  |
|-------|-------|----------|
| item1 | 0.80  | 0.37     |
| item2 | 2.77  | 0.10 .   |
| item3 | 2.77  | 0.10 .   |
| item4 | 0.13  | 0.72     |
| item5 | 0.80  | 0.37     |
| item6 | 22.45 | 0.00 *** |
| item7 | 0.13  | 0.72     |
| item8 | 21.23 | 0.00 *** |
| item9 | 0.13  | 0.72     |

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|        |       |          |
|--------|-------|----------|
| item10 | 0.13  | 0.72     |
| item11 | 0.13  | 0.72     |
| item12 | 2.77  | 0.10 .   |
| item13 | 0.13  | 0.72     |
| item14 | 0.13  | 0.72     |
| item15 | 0.13  | 0.72     |
| item16 | 0.80  | 0.37     |
| item17 | 2.77  | 0.09 .   |
| item18 | 3.21  | 0.07 .   |
| item19 | 4.13  | 0.04 *   |
| item20 | 50.34 | 0.00 *** |
| item21 | 5.09  | 0.02 *   |
| item22 | 9.14  | 0.00 **  |
| item23 | 5.15  | 0.02 *   |
| item24 | 6.18  | 0.01 *   |
| item25 | 3.21  | 0.07 .   |
| item26 | 0.13  | 0.72     |
| item27 | 0.13  | 0.72     |
| item28 | 1.54  | 0.21     |
| item29 | 0.80  | 0.37     |
| item30 | 0.80  | 0.37     |
| item31 | 1.79  | 0.18     |
| item32 | 0.05  | 0.83     |
| item33 | 26.32 | 0.00 *** |
| item34 | 21.37 | 0.00 *** |
| item35 | 0.80  | 0.37     |
| item36 | 6.18  | 0.01 *   |
| item37 | 2.68  | 0.10     |
| item38 | 2.09  | 0.15     |
| item39 | 2.68  | 0.10     |
| item40 | 0.13  | 0.73     |
| item41 | 1.41  | 0.24     |
| item42 | 0.00  | 1.00     |
| item43 | 0.00  | 1.00     |
| item44 | 0.12  | 0.73     |
| item45 | 0.80  | 0.37     |
| item46 | 0.24  | 0.63     |
| item47 | 0.24  | 0.63     |
| item48 | 3.21  | 0.07 .   |
| item49 | 0.00  | 1.00     |
| item50 | 0.24  | 0.63     |

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Detection threshold: 3.8415 (significance level: 0.05)

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Table 2 shows the chi-squares and p-values for differential item functioning of the items in the Mathematics multiple choice test set and administered by WAEC 2021. Eleven

items; Item 6, item 8, item 19, item 20, item 21, item 22, item 23, item 24, item 33, item 34, and item 36 with associated probability level ( $p < 0.05$ ) and detection threshold

( $\chi^2 > 3.8415$ ) were flagged for significant differential item functioning. Out of the 11 items that exhibited significant DIF, seven items (item 6, 8, 23, 24, 33, 34, and 36) are in favour of males (the focal group) while four items (item 19, 20, 21, and 22) are in favour of females (reference group). It implies that 22% of the 50 items in the Mathematics multiple choice test set and administered by WAEC 2021 exhibited significant differential item functioning by gender.

### Discussions of Findings

The findings of this study were organized and discussed in line with the research question that guided the study.

#### Research question 1

Which of the items in WAEC 2021 Mathematics Multiple choice test exhibit DIF among male and females test takers? The results from analysis of Research Question 1 using the M-H procedure showed that 11 items which represents 22% of the 50 test items of the mathematics multiple choice section displayed significant Gender DIF at 0.05 level of significance. Seven items out of the 11 items that exhibited significant DIF are in favour of males while four items are in favour of females.

The above findings are in line with the findings of Inyang (1991) who carried out a research on the incidence of DIF in mathematics multiple choice test administered by WAEC in 1990. In the study, 15 test items showed evidence of Gender bias in favour of male test takers while 2 test items differentially functioned in favour of female test takers. Also, this current study corresponds with the study carried out by Zimba and Chafutwa (2019) where he investigated on the incidence of Differential Item Functioning (DIF) on gender in Malawi School Certificate of Education (MSCE) Computer studies examination items using a Classical Test

Theory (CTT) based Mantel-Haenszel (MH) DIF detection procedure. The results showed that 3 items out of 34 items representing 8.82% displayed significant dif. Thus, out of the detected item bias, 66.67% had uniform DIF disadvantaged against females.

This is evidence that mathematics has been male stereotyped and consequently Gender biased since the subject is viewed as abstract as well as difficult, and only reserved for males. This is why more males are seen in engineering and other related courses and females are more inclined to language studies. Consequently, the researcher recommended that test development experts should ensure that test items are relevant to the construct being measured to enhance bias-free items. On the contrary, these findings are not in consonance with the findings of Ndifon, Umoinyang and Idiku (2018) who studied Differential Item Functioning (DIF) based on gender, school location and school ownership in 2010 Junior Secondary Certificate Examination (JSSCE) in mathematics in the Southern Educational Zone of Cross River state. Here, the findings showed that there was no significant gender differential item functioning. That is; there were no items that functioned differentially between male and female students.

### Conclusions

Based on the findings of this study, the following conclusions were made:

1. There are items in WAEC 2021 Mathematics Multiple Choice Test that exhibited Differential Item Functioning among male and female test takers.

The results of the analyses using the 3 detection methods of M-H procedure, R and dif R show that there is a slight significant difference in the functionality of gender and location in the WAEC examination. The results showed some magnitude of items bias of mathematics multiple choice of 2021 WAEC tests. Even though the tests may be highly reliable, some items are prone to DIF,

that is to say that no mathematics items used in standardize examination could be entirely free from DIF. Hence, the study concluded

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## References

- Adesemowo, (2016). Effects of Teachers' Gender and Qualification on Students' Performance in Vocational Technical Education. *Journal of Technical Education and Training*, 8(1),34-42.
- Anigbo, L.C.(2014), *Teachers' Handbook On Measurement and Evaluation*. Executive Press Resources Limited: Ogui New Layout, Enugu.
- Arogundade, B.B. and Belo F. A. (2019). Quality Assurance and Internal Efficiency of Primary School Teachers in Ekiti State. *Mediterranean Journal of social sciences*, 10(2), 49-55
- Chakraborty, B. (2022). Book Review Essay: Legalizing Sex: Sexual Minorities, AIDS, and Citizenship in India. *Journal of International Women's Studies*, 23(1), 421-424.
- Ezeamaenyi, M. V. N. (2014), *Facing Challenges of the Third Millennium through Varieties in Mathematics Science and Computer Education*. Cheston Agency (Press) LTD: 2<sup>nd</sup> Edition, Nigeria.
- Federal Republic of Nigeria FRN, (2014). *National Policy on Education*. (6<sup>th</sup> ed.) Lagos. NERDC Press.
- Igbokwe, D. I. (2013). An Assessment of the Foundation for a Suitable Science and Technological Development in Nigeria. *Journal of Issues on Mathematics*, 6(1), 18-30.
- Ndifon, J. N., Umoinyang, I. E. and Idiko, F. O. (2018). Differential Item Functioning of 2010 Junior Secondary School Certificate Mathematics examination in Southern Educational Zone of Cross River State, Nigeria. *41<sup>st</sup> Annual*

that the items used by WAEC in the examinations are gender biased for test takers

## Conference of International Association for Educational Assessment.

- Nwadinigu, I. P. and Azuka-Obieke, U. (2012). The Impact of Emotional Intelligence on Academic Achievement of Senior Secondary School Students in Lagos, Nigeria. *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS)*, 3(4), 395-401.
- Pascarella E. T. and Terenzini I. (2019). *How College Affects Students: 21<sup>st</sup> Century Evidence That Higher Education Works*, vol.3. Sam. Francisco: Jossey Bass
- Penfield, R. D. and Camilli, G. (2007). Differential Item Functioning and Item Bias. In C. R. Rao and S. Sinharay (Eds.), *Handbook of statistics: Vol. 26. Psychometrics* (pp. 125-167). Amsterdam: Elsevier.