Differential Estimate of Bias in Age and Gender on Mathematics Anxiety among Secondary School Adolescents in Ibadan, Oyo State, Nigeria

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Abstract. This research investigate the differential estimate of bias in gender and age in Mathematics anxiety among secondary school students in Oyo State, Nigeria. The sample size consists of 1,500 participants from some selected secondary schools in Ibadan. Expost facto design was adopted. The study instrument used was mathematics anxiety scale. Data were analysed using Mantel-Haenszel procedure for item bias in age and gender. The findings found no significant association between age and mathematics anxiety. A total of 30 items did not exhibit DIF. The significant level was greater than 0.05 ($p \leq 0.05$). This shows that there is no differential item functioning as regards adolescents' age. It was identified that items function differently only with gender. Government, stakeholders, parents and scholars are to take the results of the findings into consideration, in order to reduce the level of anxiety among students, as well as, build students' confidence and improve the performance of students in mathematics examinations or test.

Keywords: Mathematics anxiety, Differential item functioning, Secondary school adolescents in Ibadan, Oyo State

Introduction

Mathematics has a great influence on our everyday life. Its knowledge has been known to positively influence human ability to think logically as well as make decisions. Despite the importance of mathematics and its contribution to national and economic growth, there has still been an increase in students' negative attitude towards mathematics. Although a lot of researchers have studied intensively the predictors of mathematics anxiety among primary and elementary school students, yet little research work have been done on the differential estimate of bias in gender and age in mathematics anxiety among secondary school students in Oyo State, Nigeria.

Scientists agree that mathematics is the language of science and technology and also in some other disciplines like art, humanities and culture, holding the key to development and progress of the country and the whole world (Unamba et al., 2017). The learning of mathematics in schools, represents first, a basic preparation for adult life and secondly a gateway to a vast array of career choices (Musa & Dauda, 2014). The importance of mathematics can therefore not be overemphasized, as its knowledge has been identified as a key component of national growth (Reyna & Brainerd, 2007).

Despite its importance in daily life, mathematics is often viewed as a difficult topic to discuss. Such perception is in part, due to the nature of mathematics (Yüksel-şahin, 2008). Mathematics can sometimes be seen as a strange language from a foreign land, one communicated in symbols, numbers and geometric figures (Burn, 2006). This foreign language might seem too difficult to decipher or comprehend (Burn, 2006). It has been realized that many students have developed negative attitude towards the study of mathematics as a result of mass failure of students in the subject (Unamba et al., 2017). In spite of the crucial role mathematics plays in the everyday life, it has remained one of the least successful subjects in Nigerian Schools. Students dread and dislike the subject, this has greatly contributed to the persistent poor performance in national examination in Nigeria. Many students believe that mathematics competence is reversed for selected few. Studies have shown that students' performance have not yet significantly improved over the years. The percentage of students that passed mathematics at credit level from 2008 -2010 still fell between 30% and 47% except in 2008 where the percentage got up to 57% (Ndifon et al., 2010).

Research evidences show that students' failure in mathematics, poor achievement and lack of interest in mathematics is influenced by psychological factors which includes mathematics anxiety and achievement (Aremu & Taiwo, 2014; Taiwo, 2020). In the mathematical content, it appears that those who are weak in mathematics exhibited some level of anxiety (Unamba et al., 2017).

According to Kazdin (2000), anxiety is an emotion characterized by feelings of tension, worried thoughts and physical changes like increased blood pressure. Alternatively, Mariam Webster Dictionary also defined anxiety as an abnormal and overwhelming sense of apprehension and fear often marked by physical signs (such as tension, sweating and increased pulse rate) by doubt concerning the reality and nature of the threat, and by self-doubt about one's capacity to cope with situations. Anxiety impedes performance and hurts test scores or otherwise introduces inaccuracy into mathematics testing (Cizek & Burg, 2006). There are various form of anxiety which ranges from test anxiety, mathematics anxiety etc.

Mathematics anxiety is the feeling of tensions and anxiety that interferes with the manipulation of numbers and solving of mathematical problems in a wide variety of ordinary life and academic situation which could cause one to forget and lose one's self confidence (Tobias, 1993). It can also be viewed as an emotion that blocks a person's reading ability when confronted with mathematical situations (Spicer, 2004). Mathematics anxiety has to do with a sense of discomfort while required to work on mathematical problems (Ma, 2003) and with fear and apprehension to specific mathematics related situations (D'Ailly & Bergering, 1992). This may be as a result of personality type, negative attitude towards mathematics, mathematics avoidance, mathematics background, mathematics teachers' teaching behaviour, achievement levels, lack of confidence and negative experience in schools (Arem, 2003).

Datta and Scarfpin (1983) identified two types of mathematics anxiety, which they defined in terms of causal factors rather than learning outcomes. The first type is caused by mental blocks in the process of learning mathematics, while the other type results from socio-cultural influences. Mental block anxiety refers to triggers such as symbols or concepts encountered during learning, which create barriers for the learner, for example, the introduction of letters for numbers in algebra or the procedure for long division. Socio-cultural mathematics anxiety arises as a result of commonly encountered cultural beliefs about mathematics, for example, that only very clever people can do mathematics or that if you cannot learn the basic facts you will never succeed at mathematics. This type of mathematics anxiety may lead to mathematics phobia, but also sanctions people to admit in social situations that they are unable to do mathematics.

Over the years, studies have revealed some of the causal factors associated with mathematics anxiety. These variables include environmental factors such as, family pressure for higher achievement, intellectual factors such as learning styles (Uusimaki & Nason, 2004) and personality factors such as low self-esteem (Woodard, 2004), as well as gender bias which may be attributed to the belief that the male gender is gifted with calculative skills, while the females are gifted with verbal skills (Willingham et al., 1997). These circumstances might lead to self-consciousness about one's performance and anxiety, arising from not living up to the standards of parents (Yüksel-şahin, 2008). Sometimes, mathematics anxiety could be as a result of the individual's perception and belief of those in the environment he finds himself, which in turn informs their beliefs towards mathematics (Unamba et al., 2017). This anxiety is believed to have started from a very tender age and if not duly addressed, can affect the student's perception about mathematics. Such student try to run away from mathematical calculations, pre-occupy themselves with other things to avoid confrontations with maths teachers and often doubt his/her competence in solving mathematics questions.

The literature (Greenwood, 1984; Lazarus, 1974; Peterson & Fennema, 1985), overwhelmingly implies that mathematics learning is largely a function of mathematics teaching. A logical adjunct to that statement is that math anxiety may also be a function of math teaching. Usually, mathematics anxiety has its root with the teachers, the teaching of mathematics and its classroom relationship which could be either positive or negative. This is as a result of the fact that students do not just get mathematics-anxious without having a contact with mathematics. The fear of punishment, failure in mathematics and having not to meet up with expectations leads to anxiety.

Age has also been identified as a causal factor of mathematics anxiety and achievement (Josiah & Adejoke, 2014). Perry (2004), states that mathematics anxiety starts at an early age. Gender and age bias has been a militating factor and if not controlled early enough might alter the student’s performance in mathematics. Many teachers promote the false idea that females cannot perform as well as males in mathematics (Jackson & Leffingwell, 1999).

Since the study of mathematics is an accumulative discipline, that is, complex concepts are built cumulatively on more or simple concepts, a student who has not developed a solid mathematics foundation will have trouble learning higher order mathematics. Research showed that many of the students with mathematics anxiety have revealed an over reliance on mathematics procedures as opposed to actually understanding the mathematics concept. When students resort to memorizing procedures, rules, and routines without much understanding, the concept is forgotten and panic sets in. Experts argue that “mathematics anxiety” can bring about rife, intergenerational discomfort with the subject, which brings effects ranging from fewer students pursuing mathematics and science careers to less public interest in the subject. Mathematics anxiety can become a generational problem, with adults uncomfortable with mathematics, passing negative feelings on to their children or students.

Consequences of mathematics anxiety are quite numerous and detrimental to the career choice and interest of the student. It also affects the decision making process of the student that is sensitive to numbers (Ashcraft, 2002). It can affect the cognitive skills such as the working memory which is a significant predictor of mathematical achievement (Keeler & Swanson, 2001). Low performance can also hinder the child from moving to the next level like his peers, thereby increasing the anxiety level and reducing his confidence. The urge to curb mathematics anxiety in students and encourage positive attitude towards mathematics learning, has been a major concern for researchers since mathematics contributes immensely to national growth (Unamba et al., 2017).

Despite the importance of mathematics and its contribution to national and economic growth, there has still been an increase in students’ negative attitude towards mathematics. The fear that engulfs them when they come in contact with mathematics problems have still not been understood by scholars. This anxiety varies most times between gender and different age groups. It is mostly noticeable among the early and middle adolescent. Though a lot of researchers have studied intensively the relationship between gender and mathematics anxiety among primary and elementary school students, little research work have been done to identify the relationship between age and mathematics anxiety as well as the bias in age and gender in senior secondary schools. Some researchers have actually attested to the fact that females have a higher mathematics anxiety, but others are actually not in agreement with that because they are of the belief that the male counterparts have some level of mathematics anxiety in them but try to keep them to themselves so as not to seem weak and try as much as possible to hide the anxiety.

Even with the research of scholars that mathematics anxiety leads to low mathematics academic performance, some female students still outshine the male students in mathematics test and quiz. So if females have higher mathematics anxiety, why then do they outshine the male students in mathematics exams and test? The study seeks to identify the bias in age and gender on mathematics anxiety among secondary school adolescents in Ibadan, Oyo state. Teachers have been earlier identified as a major cause of mathematics anxiety. Teachers rarely take cognisance of the factors that contribute to low mathematics performance and in which mathematics anxiety is majorly a factor. Parents may not be aware since the teachers are usually closer to the students during school hours.

Research Questions

Research Question 1 (a): Which and how many of the items function differently between students in late and early adolescence

Research Question 1 (b): *How comparable are the DIF items from two frameworks based on adolescent age?*

Research Question 2 (a): Which and how many of the items function differently between male and female students.

Research Question 2 (b): *How comparable are the DIF items from two frameworks based on gender?*

Methods

Design

The study adopted an expost facto design which was used to identify the level of anxiety of the participants in an accurate way, through careful observation using the subset of a population. The population was studied in their natural occurrence (classroom situations through the use of questionnaire).

Population

The study's population consists of participants from some selected public secondary school students in Ibadan, Oyo State Nigeria.

Sample and Sampling Technique

The sample consists of 1500 students randomly selected from the secondary schools in Ibadan. The multi-stage sampling procedure was adopted. The simple random sampling technique was used to select six Local Government Areas (LGAs) out of 11 LGAs in Ibadan, Oyo State, Nigeria. Secondary schools who had poor consistent records of Mathematics were purposively sampled. Students with consistent low records in Mathematics were selected. The respondents were screened with Mathematics Anxiety Scale developed by Betz (1978) and those who scored high on the scales were randomly selected through the simple random sampling technique.

Research Instrument

The data instrument used for the study was adopted from Taiwo and Rasaq (2018). It consists of two sections (A and B). Section A taps information on the socio-demographic characteristics of the participants such as school, age, gender, religion and class. Section B contains 30 items on mathematics anxiety with Likert response format. The typical example of items: "Mathematics is one of the toughest subjects, "I cannot cope with Mathematics". The reliability coefficient of the scale was 0.83, which means the scale is highly reliable for this study.

Data Analysis

This study made use of Mantel-Haenszel analysis, Item Response Theory to analyse the findings of the study. Mantel-Haenszel and IRT was used to test how many items function differently male and female gender as well as their individual age.

Results

Research Question One (a): Which and how many of the items function differently (DIF) between students in late and those in early adolescence using (a) CTT framework and (b) IRT framework and how comparable are the DIF items from the two framework?

To determine the items that function differently between students in the late and those in the early adolescence using CTT framework Mantel-Haenszel (M-H) analysis was conducted using 2x2 factorial analysis. The factors were adolescent age (Early versus Late) and response (Wrong versus Right). Table 1 presents Mantel-Haenszel (M-H) analysis of DIF, the association chi-square, the significance level and decision. When the associated chi-square level is significant, there is DIF, when it is not there is no DIF.

Table 1. CTT analysis of DIF using M-H method with respect to adolescent age

Item	School	Wrong	Right	Mantel-Haenszel	Sig	Decision
1	Early	-	80	-	-	-
	Late	-	119			
2	Early	50	30	1.014	.964	No DIF
	Late	74	45			
3	Early	37	43	1.036	.904	No DIF
	Late	54	65			
4	Early	50	30	.978	.940	No DIF
	Late	75	44			
5	Early	68	12	1.285	.522	No DIF
	Late	97	22			
6	Early	67	13	1.169	.685	No DIF
	Late	97	22			
7	Early	64	15	1.101	.793	No DIF
	Late	93	24			
8	Early	56	24	1.012	.970	No DIF
	Late	83	36			
9	Early	24	56	1.330	.379	No DIF
	Late	29	90			
10	Early	2	78	.737	.728	No DIF
	Late	4	115			
11	Early	74	6	1.131	.818	No DIF
	Late	109	10			
12	Early	31	49	1.078	.800	No DIF
	Late	44	75			
13	Early	53	27	1.152	.642	No DIF
	Late	75	44			
14	Early	69	11	1.192	.669	No DIF
	Late	100	19			
15	Early	71	9	.803	.645	No DIF
	Late	108	11			

16	Early	53	27	1.032	.918	No DIF
	Late	78	41			
17	Early	72	7	1.176	.746	No DIF
	Late	105	12			
18	Early	61	19	1.035	.920	No DIF
	Late	90	29			
19	Early	55	25	1.114	.727	No DIF
	Late	79	40			
20	Early	38	42	1.386	.264	No DIF
	Late	47	72			
21	Early	71	9	.968	.943	No DIF
	Late	106	13			
22	Early	21	59	1.056	.869	No DIF
	Late	30	89			
23	Early	18	62	1.212	.588	No DIF
	Late	23	96			
24	Early	52	28	1.051	.870	No DIF
	Late	76	43			
25	Early	57	23	1.163	.633	No DIF
	Late	81	38			
26	Early	43	37	.999	.997	No DIF
	Late	64	55			
27	Early	59	21	.990	.975	No DIF
	Late	88	31			
28	Early	36	44	1.129	.677	No DIF
	Late	50	69			
29	Early	64	16	.958	.907	No DIF
	Late	96	23			
30	Early	71	9	.968	.943	No DIF

The M-H and the associated chi-square statistics tested the hypothesis that administered mathematics anxiety scale on item I (i= 1, 2, 3…30) is independent of the adolescent age (at $p \leq 0.05$ two tailed tested). A significance value, for an item that is less than 0.05 indicates that mathematics anxiety scale of the examinee on the items is dependent on their adolescent age and such item displays DIF. On the other hand p value of an item greater than 0.05 indicates that examinees mathematics anxiety scale on the item is independent of adolescent age. From Table 1 a total of 30 items did not exhibit DIF, that is associated chi-square is not significant. This items includes; items 2, 3, 4, 5, +28, 30.

To determine items that function differently between students in the late and early adolescents using IRT framework. The DIF option of JMetrik was conducted. The analysis shows that the differences in the difficulty parameter of the items in terms of the focal group (late adolescence) or the reference group (early adolescence).

Table 2. IRT analysis of DIF with respect to adolescent age

Item	Dif	P-value	Decision	Class	Description
1	NaN	NAN	NaN	B-	-
2	0.01	0.93	No DIF	A	Normal
3	0.03	0.86	No DIF	A	Normal
4	0.00	0.98	No DIF	A	Normal

5	0.28	0.59	No DIF	A	Normal
6	0.07	0.79	No DIF	A	Normal
7	NaN	NaN	Nan		-
8	0.02	0.88	No DIF	A	Normal
9	0.54	0.46	DIF	A	Normal
10	0.06	0.80	No DIF	A	Normal
11	0.00	0.99	No DIF	A	Normal
12	0.00	0.97	No DIF	A	Normal
13	0.09	0.77	No DIF	A	Normal
14	0.02	0.88	No DIF	A	Normal
15	0.68	0.41	DIF	A	Normal
16	0.02	0.89	No DIF	A	Normal
17	NaN	NaN	NaN	B-	-
18	0.02	0.89	No DIF	A	Normal
19	0.09	0.77	No DIF	A	Normal
20	0.70	0.40	DIF	A	Normal
21	0.02	0.88	No DIF	A	Normal
22	0.02	0.89	No DIF	A	Normal
23	0.08	0.78	No DIF	A	Normal
24	0.02	0.88	No DIF	A	Normal
25	0.36	0.55	No DIF	A	Normal
26	0.02	0.90	No DIF	A	Normal
27	0.04	0.85	No DIF	A	Normal
28	0.01	0.93	No DIF	A	Normal
29	0.04	0.84	No DIF	A	Normal
30	0.15	0.70	No DIF	A	Normal

Table 2 shows the IRT DIF statistics on testee’s item mathematics anxiety scale and adolescent age. Column 1 of the table provides the IRT DIF statistics for testees. Column 2 gives p-value of the IRT DIF with respect to the varying difficulty parameter estimate of the adolescent ages. Column 3 gives decision based on the p-value while column 4 describes if the nature of the DIF favours the focal group (late adolescence) or the reference group (early adolescence). That is “A” implies no DIF, B+ and C+ implies DIF favouring the focal group while B- and C- implies DIF favouring the reference group. Although 3 items (i.e. items; 1, 7, 17) were removed because they displayed non-purified matching score. However, Table 3 reveals that Mathematics anxiety scale displayed a free DIF based on adolescent age except item 1, 7 and 17.

Research Question One (b): How comparable are the DIF items from two frameworks based on adolescent age?

The research question is administered by examining and comparing the items which exhibited DIF under CTT and those that exhibited DIF under IRT. Analysis of the DIF from the contrasting frameworks shows some element of similarity. This similarly is shown in the distribution of items exhibited DIF under CTT and IRT presented in Table 3.

Table 3. Distribution of items exhibiting DIF under CTT and IRT framework

Model	Number showing DIF	Item
CTT	0	0
Item Excluded	1	1

IRT	0	0
Item Excluded	4	1,7 and17
Common Items		0
Item Excluded	1	1

Table 3 shows that there was no items exhibiting DIF under IRT and CTT. Although there are similarities in the items excluded in CTT and IRT because the items did display non-purified matching score. The table shows that 1 items were common to both CTT framework and IRT framework in terms of items excluded.

Research Question Two (a): Which and how many of the items function differently (DIF) between male and female students using (a) CTT framework and (b) IRT framework and how comparable are the DIF items from the two framework?

To determine the items that function differently between male and female students using CTT framework Mantel-Haenszel (M-H) analysis was conducted using 2x2 factorial analysis. The factors was gender (male versus female) and response (Wrong versus Right). Table 4 presents Mantel-Haenszel (M-H) analysis of DIF, the association chi-square, the significance level and decision. When the associated chi-square level is significant, there is DIF, when it is not there is no DIF.

Table 4. CTT analysis of DIF using M-H method with respect to gender

Item	Gender	Right	Wrong	Mantel-Haenszel	Sig	Decision
1	Male		97	-	-	
	Female		102	-	-	
2	Male	47	50	.305	.000	DIF
	Female	77	25			
3	Male	32	65	.359	.001	DIF
	Female	59	43			
4	Male	45	52	.238	.000	DIF
	Female	80	22			
5	Male	75	22	.455	.044	DIF
	Female	90	12			
6	Male	73	24	.368	.012	DIF
	Female	91	11			
7	Male	81	16	1.532	.239	No DIF
	Female	76	23			
8	Male	64	33	.698	.247	No DIF
	Female	75	27			
9	Male	23	74	.746	.364	No DIF
	Female	30	72			
10	Male	3	94	1.053	.950	No DIF
	Female	3	99			
11	Male	91	6	1.649	.352	No DIF
	Female	92	10			
12	Male	21	76	.246	.000	DIF
	Female	54	48			
13	Male	85	12	9.719	.000	DIF
	Female	43	59			
14	Male	82	15	.943	.881	No DIF

	Female	87	15			
15	Male	91	6	2.413	.084	No DIF
	Female	88	14			
16	Male	63	34	.926	.798	No DIF
	Female	68	34			
17	Male	85	9	1.027	.957	No DIF
	Female	92	10			
18	Male	79	18	1.829	.076	No DIF
	Female	72	30			
19	Male	61	36	.673	.193	No DIF
	Female	73	29			
20	Male	42	55	1.048	.871	No DIF
	Female	43	59			
21	Male	88	9	1.428	.437	No DIF
	Female	89	13			
22	Male	7	90	.103	.000	DIF
	Female	44	58			
23	Male	6	91	.126	.000	DIF
	Female	35	67			
24	Male	75	22	3.152	.000	DIF
	Female	53	49			
25	Male	59	38	.452	.012	DIF
	Female	79	23			
26	Male	36	61	.258	.000	DIF
	Female	71	31			
27	Male	71	26	.934	.833	No DIF
	Female	76	26			
28	Male	35	62	.565	.048	DIF
	Female	51	51			
29	Male	72	25	.458	.035	DIF
	Female	88	14			
30	Male	84	13	.625	.306	No DIF
	Female	93	9			

The M-H and the associated chi-square statistics tested the hypothesis that administered mathematics anxiety scale on item I (i= 1, 2, 3 ...30) is independent of gender (at $p \leq 0.05$ two tailed tested). A significance value, for an item that is less than 0.05 indicates that mathematics anxiety scale of the examinee on the items is dependent on their gender and such item displays DIF. On the other hand p value of an item greater than 0.05 indicates that examinees mathematics anxiety scale on the item is independent of gender. From Table 4 a total of 14 items exhibited DIF; by implication, associated chi-square is significant. This items includes; items 2, 3, 4, 5, 6, 12, 13, 22, 23, 24, 25, 26, 28, and 29.

To determine items that function differently between male and female students using IRT framework. The DIF option of Jmetrik was conducted. The analysis shows that the differences in the difficulty parameter of the items in terms of the focal group (female testees) and the reference group (male testees).

Table 5. IRT analysis of DIF with respect to gender

Item	IRT analysis	P-value	Decision	Class	Description
1	NaN	NaN	Nan	B-	-
2	2.48	0.11	No DIF	A	Normal
3	11.80	0.00	DIF	B+	Favour females
4	13.62	0.00	DIF	C+	Favour females
5	0.09	0.77	No DIF	A	Normal
6	0.96	0.33	No DIF	A	Normal
7	NaN	NaN	Nan	B-	-
8	0.04	0.83	No DIF	A	Normal
9	0.47	0.49	No Dif	A	Normal
10	0.37	0.54	No DIF	A	Normal
11	6.00	0.01	DIF	B-	Favour males
12	10.69	0.00	DIF	B+	Favour females
13	38.64	0.00	DIF	C-	Favour males
14	2.31	0.13	No DIF	A	Normal
15	5.51	0.02	DIF	B-	Favour males
16	1.84	0.17	No DIF	A	Normal
17	NaN	NaN	Nan	B-	-
18	8.52	0.00	DIF	B-	Favour males
19	0.07	0.07	No Dif	A	Normal
20	0.09	0.77	No DIF	A	Normal
21	2.01	0.16	No DIF	A	Normal
22	22.37	0.00	DIF	C+	Favour females
23	20.22	0.00	DIF	C+	Favour females
24	21.10	0.00	DIF	C-	Favour males
25	1.36	0.24	No DIF	A	Normal
26	14.16	0.00	DIF	C+	Favour females
27	7.33	0.01	DIF	B-	Favour males
28	3.03	0.08	No DIF	A	Normal
29	3.13	0.08	No DIF	A	Normal
30	2.62	0.11	No DIF	A	Normal

Table 5 shows the IRT DIF statistics on testees item mathematics anxiety scale and gender. Column 1 of the table provides the IRT DIF statistics for testees. Column 2 gives p-value of the IRT DIF with respect to the varying difficulty parameter estimate of gender. Column 3 gives decision based on the p-value while column 4 describes if the nature of the DIF favours the focal group (female testees) or the reference group (male testees). That is “A” implies no DIF, B+ and C+ implies DIF favouring the focal group while B- and C- implies DIF favouring the reference group. Although 4 items (i.e items 1, 7, and 17) were removed because they displayed non-purified matching score. However, Table 4 reveals that fifteen items (i.e. items; 2, 5, 6, 8, 9, 10, 14, 16, 19, 20, 21, 25, 28, 29, 30) of Mathematics anxiety scale displayed a DIF free test based on gender. While 6-itmes (i.e. items; 11, 13, 15, 18, 24, 27) were shown to favour male testees and 6-items (i.e items; 3, 4, 12, 22, 23, 26) were favouring female testees.

Research Question Two (b): How comparable are the DIF items from two frameworks based on gender?

The research question is administered by examining and comparing the items which exhibited DIF under CTT and those that exhibited DIF under IRT. Analysis of the DIF from the contrasting frameworks shows some element of similarity. This similarly is shown in the distribution of items exhibited DIF under CTT and IRT presented in Table 6.

Table 6. Distribution of items exhibiting DIF under CTT and IRT framework

Model	Number showing DIF	Item
CTT	23	2, 3, 4, 5, 6, 12, 13, 22, 23, 24, 25, 26, 28, 29.
IRT	15	3, 4. 11, 12, 15, 18, 22, 23, 24, 26, 27.
Common Items	9	3, 4, 12, 22, 23, 26.

Table 6 shows that items which exhibited DIF under IRT (11 items) shows some element of similarity to those items which exhibited DIF under CTT (14- items). The table shows that 6 items were common to both CTT framework and IRT framework.

Summary of Findings

The following are the summary of findings drawn from this study.

i. There were no items exhibiting DIF under IRT and CTT. Although there are similarities in the items excluded in CTT and IRT because the items did display non-purified matching score. The table shows that 1 items were common to both CTT framework and IRT framework in terms of items excluded.

ii. Items which exhibited DIF under IRT (11 items) shows some element of similarity to those items which exhibited DIF under CTT (14- items). The table shows that 9 items were common to both CTT framework and IRT framework

Discussion of Findings

This study has been carried out to identify the differential item functioning of bias in age and gender on mathematics anxiety among secondary school adolescents in Ibadan metropolis.

The research question indicates that which and how many of the items function differently (DIF) between students in late and early adolescence?

This study found that there was no differential item functioning in the 30 items that were administered to the testees. The study shows that the mathematics anxiety scale is independent of the adolescent age. This is because the significance value indicated by the mathematics anxiety scale was greater than 0.05, although 3 items (i.e. items 1, 7, 17) were removed because they displayed a non-purified matching. This is consistent with the findings of studies such as (Bitner et al, 1994; Woodard, 2004). These studies suggest no significant difference in mathematics anxiety with age. Also, it was noted that younger and older adolescents responded to the mathematics anxiety scale similarly.

This is as a result of the fact that irrespective of the age of the student, their anxiety level is only dependent on their attitude towards mathematics and their perception of mathematics.

When the IRT and the CTT framework were compared based on adolescent age, the study found out that there was no item exhibiting DIF under IRT and CTT. Although, there were similarities in the items excluded in CTT and IRT because the items did display non-purified matching score. Only one item was common to both CTT framework and IRT framework in terms of excluded items.

The study identifies which and how many of the items function differently (DIF) between the male and female students?

The study shows that a total of 14 items (2, 3, 4, 5, 6, 12, 13, 22, 23, 24, 25, 26, 28, 29) exhibited DIF and also shows the presence of item bias as regards to gender. This is because 14 of the significance value were less than 0.05 which indicates mathematics anxiety scale of the examinees is dependent on gender and such item displays DIF. While 6 items (11, 13, 15, 18, 24, 27) were shown to favour the reference group (males) and 6 items (3, 4, 12, 22, 23, 26) favoured the focal group (females). The Item Response Theory (IRT) was used to detect bias in the items. This study is also consistent with studies of Yüksel-Şahin (2008), who identified in his study that there was a significant difference between mathematics anxiety scores of males and females. Arem (2003), also found a significant difference in secondary school student’s anxiety in mathematics with respect to gender. He noted that female students reported significantly higher mathematics anxiety than males. Yüksel-Şahin (2008), reported that the stereotypical view of this issue has a powerful impact. Female students believed boys were blessed with the advantage of mastering mathematics, while boys felt they were better able to perform in mathematics when compared to their female counterparts. Such beliefs negatively affect the ability of female students and their initial assumptions about mathematics achievement can have a long term impact on their math achievement (Minsoo, 2012)

Also using IRT framework, it was discovered that some items favoured the reference group (males) and some favoured the focal group (females). This implies that some items are more discriminating for some sub groups than the other (Langer et al., 2008).

When the DIF items from IRT and CTT were compared based on gender, the study found out that 12 items exhibited DIF under IRT shows some element of similarity to those 14 items which exhibited DIF under CTT. When they were both compared, it was identified that 7 items were common to both frameworks.

Similarly when IRT and Mantel-Haenszel methods were compared, the results were encouraging. This comparison was carried out with items that are consistently identified across samples with the same methods (Hambleton & Rogers, 1989). Of the items in this study, 14 items consistently identified and 7 items were also common in his study which is also in accordance with the findings of the study that was conducted. This implies that the items identified were more or less a subset of those identified by the area method and there is a substantial agreement between IRT-based method and the Mantel-Haenszel method in the detection of uniform DIF.

Conclusion

This study, differential estimate of bias in age and gender in mathematics anxiety among secondary school adolescents in Ibadan, Oyo state has been able to identify item bias in gender and the study did not also detect bias as regards adolescent’s age.

This study shows that gender is indeed a contributing factor in the level of anxiety experienced among students. The presence of DIF may be as a result of the way the tests are administered, the ways in which the results are used or the way the wordings of the questions were constructed. This may confuse the response of one group. With the presence of DIF, the probability of success is not the same for all test takers.

Based on the findings of the research, the teachers should take into consideration giving out equal chances to all students of the class irrespective of their gender, encourage non biased participation in mathematics test taking by helping to reduce the level of anxiety exhibited by some test takers in mathematics. Since it was discovered in the study that age is independent of mathematics anxiety, focus should be placed on the gender of the student.

Recommendations

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

1. The researcher of this study identified that items function differently only with gender rather than the adolescent age. This indicates that government, stakeholders, parents and schools are to take the results of the findings into consideration in order to reduce the level of anxiety among students.
2. The society should focus more on treating each student equally irrespective of their gender, to reduce the level of bias. Since the students first contact with mathematics is the school, the teacher should ensure that each student in the class are treated equally and are made to answer same questions.
3. The teacher should employ quality teaching strategies that will enhance mathematics teaching and make it lively. This will help reduce the level of mathematics anxiety, build student's confidence and improve the performance of students in mathematics examinations or tests.
4. Question items should be bias free regardless of gender and age of the students.
5. Mathematics teachers should be adequately trained to handle students with mathematics anxiety.
6. Mathematics teachers should ensure that no student is preferentially treated, rather all students should be given equal chances to participate in mathematics classes.
7. Parents should also encourage their children and assist them with their mathematics assignments to help them reduce the fear of failing in mathematics.
8. The regular cultural believe that boys do better than girls in mathematics should be completely eradicated.
9. Students should be encouraged even with the little effort they make in mathematics.
10. Healthy study habit should be encouraged as the child begins to study mathematics.

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