

**STUDENTS PERFORMANCE IN THREE-DIMENSIONAL
MATHEMATICS MULTIPLE-CHOICE TEST ITEMS OF NATIONAL
EXAMINATIONS COUNCIL IN SOUTH-WESTERN NIGERIA**

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Abstract

The study investigated the performance of students in three-dimensional Mathematics multiple-choice test items from the National Examination Council Senior Secondary School exams between 2011 and 2013 in southwestern Nigeria. It assessed how location affects the difficulty, discrimination, and guessing indices of these test items. The study adopted non-experimental design of descriptive research. The population of the study consist 632,238 senior secondary students and a sampled 3,503 students from six senatorial districts (one per state) in southwestern Nigeria, selected through random and purposive sampling techniques to include both rural and urban schools. The performance data, sourced from the NECO database, was analyzed using percentage and inter-item correlation. Results indicated that Ekiti students performed the best, with performance values ranging from 0-7.7% (0-39 candidates), followed by Osun State in 2011 (7.7%, 26 candidates), Lagos in 2012 (10.6%, 53 candidates), and Oyo in 2013 (5.7%, 16 candidates). The study found no significant influence of location (rural or urban) on the difficulty (b-parameter), discrimination (a-parameter), or guessing indices (c-parameter) of the three-dimensional Mathematics multiple-choice test items, with t-values indicating no significant differences (b-parameter: $t = -1.075, 0.162, 3.211$; a-parameter: $t = -0.225, -0.121, 0.524$; c-parameter: $t = -1.359, -2.819, -1.961$; $p > 0.05$). The study concluded that the three-dimensional Mathematics multiple-choice test items were consistent across the item parameters over the years reviewed. It recommended regular in-service training for Mathematics teachers and emphasized the importance of teaching three-dimensional items in schools.

Keywords: Three- Dimensional, Discrimination, Difficulty, Performance, Mathematics

Introduction

The important of Mathematics in achieving a country's scientific and technical goals is undeniable. Therefore, it is crucial to prioritise the education of young people in, Science, Technology and Mathematics (STM), since these subjects provide the foundation for industrial activity. The significance of Mathematics in achieving this objective cannot be disregarded. In his work, Musa (2012) defined Mathematics as the fundamental discipline that serves as the foundation for all discipline. Also, characterized it as the study of number and spatial relationship. Musa (2012) emphasized that Mathematics is included into the school curriculum to provide a solid groundwork for Advanced Mathematics and other science-related discipline. In addition, Ngwa (2001) said that Mathematics play a crucial and fundamental role in the scientific and technical advancement of any nation. It is an essential topic that is inseparable from the key to advancement and growth. Mathematics is a fundamental component of scientific and technological advancement in the country. It is mandatory at both the Junior and Senior levels of Secondary School Education and is a prerequisite for admission into tertiary institutions. This issue is a significant concern for teachers, educators, parents, government and all other individuals involved in education.

The long-standing issue of students under performance in Mathematics has been a major concern for mathematics instructors in Nigeria (Abakporo, 2005). One particular topic that

consistently appears in external examination in the idea sets, which falls under the boarder category of number and numeration in Mathematics. The set games encourage the use of logical thinking, which is essential for personal growth and advancement (Lassa, 2012). According to Agwagah (2007), several educators in the Mathematics area believe that the low academic achievement of pupils may be attributed to the ineffective teaching methods used by certain Mathematics instructors. The underperformance of student, in Mathematics has been a significant worry for the educators in the field of Mathematics. The yearly report on Mathematic senior school Certificate Examinations held by the National Examination Council (NECO) provide strong evidence of these facts. Mathematics instructors have exerted significant effort to identify primary issue related to Secondary school Mathematics.

Despite all these commendable efforts, the issue of poor performance in Mathematics persists. The performance in NECO 2010 was deemed unsatisfactory since the data revealed that fewer than 25% of the whole population achieved a credit level in Mathematics (Osuagwu, 2012). Furthermore, according to the study released by the National Examinations Council in collaboration with the National Bureau of Statistics, there were no student who achieved a grade of C5 in 2011. Similarly, in both 2012 and 2013, no students throughout the country obtained a grade of A1. Moreover, the reason for low grade in Mathematics in the National Examination Council (NECO) may be attributed to the students' struggle with comprehending the Three-Dimensional Mathematics Multiple questions along with other difficulties. These particular questions make up 34% of the total questions in the external examination. If the continued underperformance in Mathematics continues, the future of Science, Industries and Technology is at jeopardy. Against this backdrop, there is urgent need to empirically ascertain psychometric properties (difficulty, discrimination and guessing indices) over three period (2011-2013). The objectives of this study is to:

1. compare the performance of students in three-dimensional Mathematics multiple-choice test items of National

Examinations Council Senior Secondary School Certificate Examination from 2011 to 2013 in South - western Nigeria;

2. determine the difficulty, discrimination and guessing index of three-dimensional Mathematics multiple-choice tests items in terms of location.

Research Questions

1. What is the performance of students in three-dimensional Mathematics Multiple-choice (MCQ) test items NECO in the six states of South-western Nigeria?
2. Does location have significant influence on difficulty, discrimination and guessing parameters in three-dimensional Mathematics multiple-choice test items among the states in South-western Nigeria?

Methodology

Non-experimental design of descriptive research was adopted. The study population consisted of 632,238 Senior Secondary Students in states of Southwest zone (Osun, Ondo, Oyo, Ogun, Ekiti and Lagos state) of Nigeria who sat for Senior Secondary Certificate Examination conducted by National Examinations Council from 2011 to 2013. 2013. The study sample was drawn using multi-stage sampling procedure. An intact class of 3503 students responses used as sample from six senatorial districts in Southwest of Nigeria. One senatorial district was selected from each state in the Southwestern Nigeria using random sampling technique (Ogun Central, Osun East, Ekiti North, Ondo Central, Oyo Central, Lagos East). From each of the senatorial districts, One Local Government Area (LGAs) was selected from each of the senatorial districts using purposive sampling technique (Local Government Area where rural and urban settlement can be found); making six LGAs. Two schools (one in rural and one in urban settlement) were selected using simple random sampling techniques, making a total of 12 schools.

The students' performance (score) in Multiple Choice test item obtained from NECO database in the three-dimensional mathematics.

Each State of Southwest Nigeria had its prepared results. The results of three-dimensional Mathematics multiple-choice test items of these students were retrieved from their database covering a period from 2011 to 2013. The results were coded as '1 = correct and 0 = incorrect' for each item, an item that an examinee did not respond to were also coded as 0 while omit and incomplete test was coded =N, the students' responses to the 20, 21 and 22 in three-dimensional Mathematics multiple-choice test item from 2011, 2012 and 2013 respectively three-dimensional Mathematics multiple-choice test item were dichotomously scored using the Keys provided by the examination body. A correct option was coded '1' while wrong option and omitted was scored '0' in the excel spread sheet, Urban was coded as '1' and '2' was coded for Rural and thereafter imported to the SPSS spread sheet for possible errors. For data calibration, Thereafter, the calibration was performed for item parameters

(difficulty, discrimination and guessing) using Xcalibre 4.2 software using Statistical Package for Social Sciences (SPSS) software. Research question one was answer using percentage, research question two was answered using inter-item correlation matrix.

Results

Research Question One: What is the performance of students in three-dimensional Mathematics Multiple-choice (MCQ) test items NECO in the six states of Southwestern Nigeria?

To answer this research question, three-dimensional Mathematics multiple-choice test items (Longitude and Latitude, Bearing and Distance, Mensuration, Trigonometry & Geometry), in Mathematics multiple-choice test items conducted by National Examinations Council for Senior Secondary School Certificate Examination in year 2011, 2012 and

Table 1: Descriptive Statistics Showing the Performance of Candidates in Three Dimensional Mathematics Multiple-Choice test items in 2011-2013

Performance	2011	2012	2013	Total
0-39 (Fail)	218 (12.7%)	338(30.5%)	183(16.4%)	739
40-44 (Pass)	55(3.2%)	74(6.7%)	52(4.7%)	181
45-49 (Pas)	66(3.8%)	90(8.1%)	47(4.2%)	203
50-54 (Credit)	57(3.3%)	87(7.8%)	59(5.3%)	203
55-59 (Credit)	55(3.2%)	221(19.9%)	53(4.8%)	329
60-64 (Credit)	73(4.2%)	69(6.2%)	65(5.8%)	207
65-69 (Distinction)	90(5.2%)	68(6.1%)	77(6.9%)	235
70-74 (Distinction)	151 (8.8%)	63(5.7%)	85(7.6%)	299
75-100 (Distinction)	506(29.4%)	103(9.3%)	489(43.9%)	1098
Total	1721	1110	1113	3944

Bench Mark 50

It was found that 20 items (2 questions on Longitude and Latitude, 4 questions on Bearing and Distance, 5 questions on Mensuration, Trigonometry & Geometry takes 9 questions) of the three-dimensional Mathematics multiple-choice test items found in 2011, 22 of the items (1 questions on Longitude and Latitude, 4 questions on Bearing and Distance, 7 questions on Mensuration, Trigonometry & Geometry takes 9 questions) were found 2012 and 21 of items (1 questions on Longitude and Latitude, 6 questions on Bearing and Distance, 7 questions on Mensuration, Trigonometry & Geometry takes 7 questions) were found in 2013. The responses of candidates in three-dimensional Mathematics multiple-choice test items were converted to the percentage score for easily reading and interpretation. Further, in Table 1, the scores obtained from the students' performance in three-dimensional Mathematics multiple-choices test items were grouped as follows: scores ranging from 0-39 grouped as F9 grade, 40-44 grouped as E8 grade, 45-49 grouped as D7 grade, 50-54 grouped as C6, 55-59 grouped as C5, 60-64 grouped as C4, 65-69 grouped as B3, 70-74 grouped as B2, 75-100 grouped as A1, with A1-B3 (Distinction), C4-C6 (Credit), D7-E8 (Pass), and F9 (Fail) as subjected to descriptive statistics using frequency count and percentage to determine the various level of students' performance in three-dimensional Mathematics multiple-choice test

items, and the percentage score of less than 50% was used to categorised the performance of each states in South-western Nigeria.

The results in Table 1 showed that 218(12.7%), 55(3.2%), 66(3.8), 57(3.3%), 55(3.2%), 73(4.2%), 90(5.2%), 151 (8.8%), 506 (29.4%) candidates' grade in 2011 had their score as follows 0-39 to 75-100 respectively. Also, in 2012 it revealed that 338(30.5%), 74(6.7%), 90(8.1%), 87(7.8%), 221(19.9%), 69(6.2%), 68(6.1%), 63(5.7%), 103(9.3%), had their score ranges as follows 0-39 to 75-100 respectively, furthermore, in 2013 the 183(16.4%), 52(4.7%), 47(4.2%), 59(5.3%), 53(4.8%), 65(5.8%), 77(6.9%), 85(7.6%), 489(43.9%), had their score ranges as follows 0-39 to 75-100 respectively. It showed that in 2011, 339 candidates score less than 50 marks gives 19.68%, in 2012, 502 candidates score less than 50 marks benchmark gives 45.2% and 282 candidates score less than 50 marks benchmark gives 25.3% in 2023. The results showed that students did perform fair in 2011 compare to 2012 and 2013.

Research Question Two: Does location have significant influence on difficulty, discrimination and guessing parameters in three-dimensional Mathematics multiple-choice test items among the states in South-western Nigeria?

Table 2: Influence of Location on Difficulty, Discrimination and Guessing across the three years

Years	Parameters	School location	N	\bar{X}	SD	Df	t	P
2011	Difficulty	urban	922	1.017	0.365	1269	-1.075	0.289
		Rural	349	1.327	1.239			
	Discrimination	urban	922	0.176	1.191	1269	-0.225	0.823
		Rural	349	0.254	1.011			
	Guessing	urban	922	0.226	0.042	1269	-1.359	0.182
		Rural	349	0.241	0.025			
2012	Difficulty	urban	783	1.251	0.270	1111	0.162	0.872
		Rural	330	1.227	0.653			
	Discrimination	urban	783	0.800	1.296	1111	-0.121	0.904
		Rural	330	0.849	1.357			
	Guessing	urban	783	0.209	0.040	1111	-2.819	0.007
		Rural	330	0.253	0.061			
2013	Difficulty	urban	782	1.148	0.426	1117	3.211	0.003
		Rural	337	0.815	0.210			
	Discrimination	urban	782	-0.274	0.552	1117	0.524	0.603
		Rural	337	-0.385	0.800			
	Guessing	Urban	782	0.238	0.026	1117	-1.961	0.057
		Rural	337	0.255	0.028			

Table 2 shows the results of the 2011 National Examinations Council three-dimensional Mathematics multiple-choice test which provides several insights into the performance of students from urban and rural settlements. A higher Difficulty index suggests that the items were more difficult for the rural students compared to the urban students. This indicates that rural students found the test items more challenging than their urban counterparts. The Discriminating index measures how well an item differentiates between high and low

performers. The higher Discriminating index for rural students suggests that the test items were better at distinguishing between more and less proficient students in rural areas compared to urban areas. The Guessing parameter reflects the likelihood of students correctly guessing the answers. The slightly higher Guessing parameter for rural students suggests a marginally higher probability of guessing correctly among rural students than urban students.

Discussion of Finding

Based on the findings of the research question one, there was a notable improvement in 2012, with 45.2% of students meeting or exceeding the benchmark compared to only 19.68% in 2011. This significant increase suggests that there might have been effective interventions or improvements in teaching methods or resources during this period which implies that the content was better aligned with what students had been taught or had more practice in. There might also have been a better balance between lower and higher order cognitive skills in the test items, making the test more accessible to the students. This supports the study by Anderson and Krathwohl (2001) that demonstrated that students perform better on assessment that appropriately balance recall, application, and higher-order thinking skills. The percentage of students meeting or exceeding the benchmark decreased to 25.3% in 2013, which is a substantial drop from 2012. This decline could indicate that the improvements or interventions that were effective in 2012 were not sustained or that other factors negatively impacted student performance. This implies that the test items might have covered topics that students were less familiar with or had insufficient practice in. These findings corroborate the study carried out by William (2007) who found that alignment between test content and curriculum significantly impacts student performance. When test items closely match what is taught in the classroom, students perform better because they are assessed on familiar material.

Research question two revealed that based on the provided p-values for difficulty, discrimination and guessing for year 2011, location (specifically urban schools) does not have a statistically significant influence on any of these parameters. This implies that urban schools do not show significant difference in terms of test item difficulty, discrimination, or guessing compared to schools in the rural locations which suggests that while student performance can be influenced by various factors, the psychometric properties of standardized test items (difficulty, discrimination, and guessing) tend to remain consistent across different geographic locations. Studies from international assessments like

Programme for international Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) have shown that while overall student performance can vary by country or region, the psychometric properties of the test items (difficulty, discrimination, guessing) remain constant across different geographic locations. The findings was consistent with Clotfelter, Ladd, and Vigdor (2009) who found that while resources and teacher quality significantly impacted student outcomes, the difficulty of test items was relatively consistent across different locations. Harris and Herrington (2006) investigated the impact of location on standardized test performance and found no significant differences in test item difficulty between urban and non-urban schools when controlling for other factors such as socio – economic status. The provided p-values for 2012 indicates that urban location has a significant influence on guessing which suggests that the likelihood of students guessing the correct answer is significantly different in urban schools compared to other locations. This corroborates a study by Cassady and Johnson (2002), who explored the relationship between test anxiety and guessing. They found out that students with higher levels of test anxiety, which can be more prevalent in urban schools due to competitive academic environments, are more likely to guess. Furthermore, from the p-values provided for difficulty, discrimination and guessing for year 2013, urban location has significant influence, indicating that test items are perceived as more or less difficult in urban schools compared to other locations.

Conclusion

The study concluded that performance of candidates in three-dimensional Mathematics multiple-choice test items was vary from year to year, but performance in 2012 is very poor compare to other two years. However, 2011, 2012 and 2013 three-dimensional Mathematics multiple-choice test items, no significant influence of locations (rural or urban) on the 3-parameter of three-dimensional Mathematics multiple-choice test items.

Recommendations

It was recommended that

1. Regular in-service training for Mathematics teachers and emphasised the importance of teaching three-dimensional items in schools.
2. That psychometrics properties should be establish for test items.

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