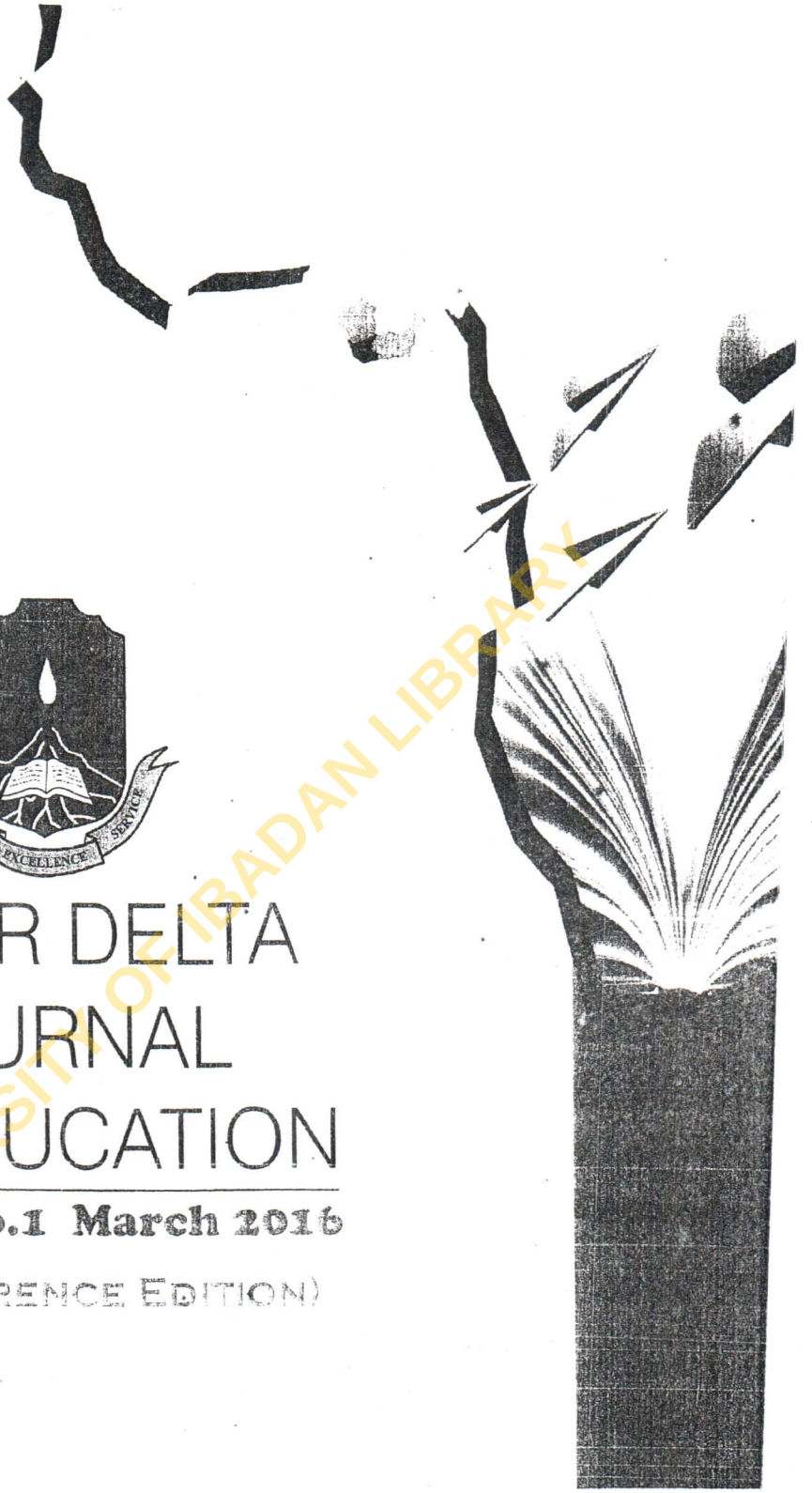

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COGNITIVE LEVEL OF TEST ITEMS AND STUDENTS' ACHIEVEMENT IN MATHEMATICS AMONG SELECTED SENIOR SECONDARY SCHOOL STUDENTS IN IBADAN, OYO STATE NIGERIA

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ABSTRACT

The study examined the effects of cognitive level of test items on academic performance of participants in multiple-choice questions in mathematics subject prepared by WAEC on senior secondary school students in Ibadan, Oyo State, Nigeria. Five hundred and twenty five students in SSS 3 were tested on a 50-item Mathematics Achievement Test. Their performances on cognitive level of test items were analyzed for the purpose of this study. Results indicated that cognitive level of test items were significantly correlated with performance of participants in mathematics multiple-choice question achievement test, and that participant performed well in lower level of cognitive domain than higher level of cognitive domain. Cognitive levels of test items are predictive of students' achievement in mathematics, among the selected senior secondary school students, in Ibadan. Hence it is recommended that the teachers should expose their learners to higher levels of cognitive domain of items during teaching-learning process so as to enhance the students' achievement in mathematics.

Keywords: Cognitive level, Achievement test, Test Items, Achievement in Mathematics; and Test Score.

INTRODUCTION

Test construction involves four major procedures of planning, item writing, item analysis and marking scheme development. For the purpose of this study, only part of the planning was discussed. The planning stage is very crucial in test construction since the quality of the test depends largely on the care taken at this critical stage. Usually, planning involves the following steps: defining objectives of the test, specifying contents, preparing a table of specification and deciding on the item format. Bloom's taxonomy of educational objectives, cognitive domain item analysis is a process which examines student responses to individual test items (questions) in order to assess the quality of those items and of the test as a whole. Item analysis is especially valuable in improving items which will be used again in later tests, but it can also be used to eliminate ambiguous or misleading items in a single test administration. In addition, item analysis is valuable for increasing instructors' skills in test construction, and identifying specific areas of course content which need greater emphasis or clarity. A basic assumption made is that

the test under analysis is composed of items measuring a single subject area or underlying ability. The quality of the test as a whole is assessed by estimating its "internal consistency." The quality of individual items is assessed by comparing students' item responses to their total test scores. Item analysis comprises testing for item difficulty, item discrimination and norms, which is made up of validity and reliability. In this study, the test being analyzed is assumed to be an already validated test because it is a past question paper used by WAEC for WASSCE.

This administration helped us to identify each item in respect to cognitive levels, which includes knowledge, comprehension, analysis, application, synthesis and evaluation. The researcher carried out cognitive level analysis of the items and not reliability nor the validity analysis of the test; this is because, the test which is being analyzed is believed to be a standardized test, and the standardized test cannot be revalidated. Cognitive level of items is a process which examines objectives of test as it appeared in the test blue print or table of specification even though the research is not the one responsible for the construction of test items (questions) in order to assess the quality and quantity of those items and of the test as a whole. It is especially valuable in improving items which will be used again in later tests, but it can also be used to eliminate ambiguous or misleading items in a given test. In addition, the cognitive levels of the items are valuable for increasing instructors' skills in test construction, and identifying specific areas of course content which need greater emphasis or clarity.

Bloom; Englehart, Furst, Hill, and Krathwohl, (1956) categorized the cognitive domain into six major levels of objectives, viz knowledge, comprehension, application, analysis, synthesis and evaluation. A new scheme by the Educational Testing Service (ETS) Princeton, New Jersey, USA, consists of three categories (1) Remembering (ii) Understanding and (iii) Thinking. Bloom's first and second categories are similar to remembering and understanding respectively, while the other four are grouped as thinking in the ETS scheme. Knowledge simply means the ability to remember or recall previously learned materials. Comprehension refers to the ability to understand the meaning of materials. For eg, translating materials from one form to another; interpreting, explaining or summarizing materials and predicting consequences and effect. Application is the ability to apply learned materials in new and concrete situations. This may include the application of such things as rules, methods, concepts, principles, laws, formulae and theories. Analysis, this refers to the ability to break down materials into its component parts that its organisational structure may be understood. For example, identification of parts and recognition of the organizational principles involved.

The behaviours which have been described here are certainly not exhaustive. For example, some measurement and evaluation literature include synthesis and evaluation in their list of behaviours. Synthesis relates to the ability to put parts together to form a new whole and evaluation is related to the ability to judge the value of materials for a given purpose. It is probably better to leave these two behaviours to the measurement and evaluation of the achievement of the more advanced students. Furthermore, they are subsumed in analysis. According to Obemeata (1999), test constructors and examiners are rarely unanimous on which objective a particular test item measures because a particular test item may measure one testee's comprehension and another testee's application. The main reason for the usual disagreement among test constructors and test users over the behaviour which a particular test item measures is that the test constructor has to infer for himself the mental process which is being measured by the form and content of a question and he does this from his experience of teaching students for whom the test is intended. Bloom's category of application has been has been defined

differently by different people. Where there is disagreement by different people over what a test item measures, the way out is to rely on consensus judgement. If the majority of test users or examiners agree that a certain test item measures a particular process, it is accepted that the process is what the test item actually measures.

This study is important because it helps the tester to prepare and present only appropriate items to the testees. Such items that will help discriminate between the high achievers and the low achievers, and that will help the tester know where to give the students more attention in teaching.

The importance of Mathematics as a subject cannot be over emphasized. It is a study of daily activities in the real world. While some call it the study that broadens the thinking faculty, others say it is a science that studies that gives birth to other sciences and disciplines like Chemistry, Physics, Technology, Agric Science, Medicine etc. Mathematics is a science that attempts to explain how production, distribution and consumption of goods and services are carried out on daily basis. This is why the subject is taught starting from primary school to secondary school level, to teach the students about real life situations that they may be engaged in sooner or later in their life time. It is important that the students understand this subject properly for national development. And one of the ways to ascertain this is by analyzing the items of the tests and administered it to the students; this will help the instructor, teacher or tester to know where more work is needed. Mathematics classroom lesson in Oyo state are characterized with highly teacher-centered. Most teachers are not well trained, schools are not well-equipped with mathematics apparatus, practical lessons and activities are not encouraged due to inadequate facilities as a results students do not have interest in mathematics lesson, students are bored, they are not actively engaged, learning mathematics becomes more or less abstract and not concretize. Consequently, there have been high rate of failure in external examinations in the mathematics subject. Most often results of West African Examination Council, National Examination Council and National Business and Technical Examinations Board testify to these poor performances. To solve this problem, the researcher has decided to analyze the test items, using cognitive level of items to actually showcase the areas of weakness of the testees so as to know where the teachers need to lay more emphasis during the teaching-learning process.

Statement of the Problem: The predicament of our educational system as implicated by poor academic performance of secondary school students in mathematics constitutes a challenge to the attainment of sustainable development. The consequences of not addressing the problem of academic performance in mathematics, so far, have been enormous; culminating into an increased number of drop-outs and also contributing largely to the spate of social vices plaguing the nation.

The issue of poor academic performance in mathematics among secondary school students, as it festers alarmingly, is so dreadful that one wonders if such records may not be reflection of certain unidentified factors. Of course, it is hoped that while government has so far accorded sizeable recognition to certain challenges, which reside in institutional system of education, instructional and structural qualities in schools and has so far fixed them to certain extent, it is expected that academic performance of students in mathematics should improve accordingly. In the light of this, the researcher takes a look at the cognitive level of items as probably one of the factors responsible for poor performance in mathematics. Since cognitive

level of item analysis has to do with low and high order of thinking, some students may not be able to attain minimum requirement that will make them to perform in some higher order of thinking items. The question that comes to mind from this is that: Can a cognitive level items analysis enhance teachers' teaching-learning process and construction of item and consequently affect students' achievement in mathematics?

Purpose of the Study

The purpose of this study is to determine the influence of cognitive level of test items in mathematics paper prepared by WAEC viz-a-viz the academic performance of testees on mathematics achievement test and to determine the areas of weakness of the testees in the cognitive level of test items.

Significance of the Study

This study will assist in identifying the cognitive level that is problematic to testees and this will help in enhancing their performance in mathematics because their teachers will know where their problem lies. It will also prevent wasting the time of the learners if they could pass the examination in record time. Teachers will also benefit from it in the sense that they will know where more emphasis will be needed in the course of teaching and learning. The parents and the stake holders will also benefit from it in the sense that it will prevent wastages in terms of paying school fees and annual budget.

Scope of the Study

The study covered 525 secondary school students in Ibadan metropolis, Oyo State, Nigeria. It also looked at mathematics multiple choice questions, prepared by the West African Examination Council.

Research Questions

The following research questions were postulated to guide the study:

RQ1: What is the relationship that exists among cognitive levels of test items and mathematics achievement test among participants?

RQ 2: Which of the cognitive level of test items has the participants performed best?

METHOD

This study made use of descriptive survey research design, which does not involve direct control of any variable or any experimental manipulation. The target population for this study consists of all mathematics SSS3 students in all the public secondary schools in Ibadan, Oyo state. There are about two hundred and fifty nine secondary schools with about thirty two thousand two hundred and eighty senior secondary school students in Ibadan metropolis. The study is restricted to five local government areas in Ibadan land with three selected secondary schools in each local government. The sample size for this study was made up of five hundred and twenty five senior secondary school (SSS) students, using simple random sampling procedure to select schools and students in each local government area. The participants were made up of 289 boys and 236 girls, with average age of 17years. Mathematics Achievement Test consists of 50 multiple choice questions, based on topics which senior secondary school students were expected to be exposed to. This test was designed by WAEC. The principals of the

chosen schools were briefed about the purpose of the study so as to obtain permission for the researcher to make use of their pupils for the study. The pupils were informed as well. In a situation where a chosen school has more than one arm, an arm was taken at random and in situation where there was only one arm in the school; the whole SS3 students in such school were used. The data collected were analyzed, using frequency counts and percentages, correlation analysis, Analysis of Variance and post hoc-analysis of Scheffe at $\alpha = 0.05$ level of significance.

Results:

Results of the study are presented below:

RQ1: What is the relationship that exists among cognitive level of test items and mathematics achievement test among participants?

Table 1: Summary of the Inter-Correlation Matrix Showing Relationship Between the Independent Variables and Students' Achievement in Mathematics

Sources	1	2	3	4	5	6	7
Achievement	1.000						
Knowledge	0.497	1.000					
Comprehension	0.513	0.520	1.000				
Analysis	0.287	0.252	0.037	1.000			
Application	0.332	0.080	0.053	0.049	1.000		
Synthesis	0.197	0.038	0.045	0.109	0.332	1.000	
Evaluation	0.543	0.012	0.045	0.109	0.041	0.037	1.000

Table 1 shows that there is positive significant relationship between each of the independent variables and the students' achievement in mathematics. For instance, students' achievement in mathematics is significant and positively related with knowledge ($r = 0.497$; $p < 0.05$); with comprehension ($r = 0.513$; $p < 0.05$); with analysis ($r = 0.287$; $p < 0.05$); with application ($r = 0.332$; $p < 0.05$); with synthesis ($r = 0.197$; $p < 0.05$) and with evaluation ($r = 0.543$; $p < 0.05$). This implies that change in each of the independent variables brings about change in the students"achievement in mathematics.

RQ2: To which of the cognitive level of test items has the participants performed best?

Table 2: Summary of Analysis of Variance of Independent Variables on Students' Achievement in Mathematics

Source	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Within	1137.34	5	227.47	35.82	0.05	Significant
Residual	3293.17	519	6.35			
Total	4430.51	524				

Table 2 reveals that there is significant difference in the students' achievement in mathematics based on cognitive level of test items with $F_{(5,519)} = 35.82$; $p < 0.05$. This implies that there is a significant impact of the cognitive level of test items in the students' achievement in mathematics. For further clarification on the margin of differences between the cognitive levels of test items, a Scheffe post-hoc analysis which shows the comparison of the adjusted mean was computed and the result is as shown in Table 3.

Table 3: Scheffe Post-Hoc Analysis Showing the Significant Differences among Cognitive Levels of Test Items

Religion	N	Subset for alpha = 0.05		
		1	2	3
Knowledge	28	64.4426		
Comprehension	206		57.9508	
Application	105		49.3171	
Analysis	76			31.3000
Synthesis	52			31.7901
Evaluation	58			22.0001
Sig.		1.000	.058	.287

Means for groups in homogeneous subsets are displayed.

From Table 3, it revealed that knowledge has the highest mean score (mean score = 64.44), compared with others and it is followed by comprehension with mean score of 57.95 followed by application with mean of 49.31. Comprehension and application levels of cognitive domain have mean scores of (57.95 and 49.32) respectively and they both form another group which is the second group while analysis, synthesis and evaluation levels of cognitive domain have the mean scores of 31.30, 31.79 and 22.00 respectively and these levels of cognitive domain form the third group. The findings showed that learners performed much better in knowledge, comprehension and application while performance was not encouraging in analysis, synthesis and evaluation cognitive levels of test items.

Discussion of Findings

This study examined students' achievement in mathematics among selected senior secondary school students in five local government areas that of Ibadan metropolis. The cognitive item analysis was based on Bloom's taxonomy, cognitive domains, which consist of six factors knowledge, comprehension, analysis, application, synthesis and evaluation.The result reveals that there is significant relationship between each of the independent variables and students' achievement in mathematics. For instance students' achievement in mathematics is significant and positively related with knowledge, comprehension, analysis, application, synthesis and evaluation. This shows that change in each of the independent variables will bring about change in the students' achievement in mathematics.

The current findings corroborate those of Osokoya (2012) and Muriana (2015) on lower order of cognitive domain with the notion that students' achievement in mathematics is always better with lower order cognitive levels of domain. It is also in line with Bloom taxonomy (1956) who discovered that learners performed better in lower order of cognitive domain more than the test that has to do with higher thinking. The probable reason for this may be that knowledge, comprehension and analysis do not require much thinking like other domain of cognitive ability.The result of research question 2 indicated that there was significant difference in the performance of students based on level of cognitive domain and that the post-hoc analysis indicated that the students performance in mathematics, based on cognitive domain, categorised the cognitive domains into three categories with lower, moderated and higher order of thinking. The results indicates that students performed best in lower order thinking, followed by moderate order of thinking items and finally followed by higher order of thinking of cognitive domain. This result indicates that students are not good in the area of higher order thinking in mathematics items prepared by WAEC. This result corroborates findings of Osokoya (2012) with her findings in WAEC Chemistry and Muriana (2015) in Mathematics paper prepared by him. They both discovered that the testees did perform better in lower order thinking items. The students do fail mathematics as a results that the bulk of the questions set, came from higher order of thinking (analysis, synthesis and evaluation) levels. This result is contrary to that obtained by Olatunji (1974) when she analyzed the essay questions set in different departments of a university. The predominance of these two levels of questions could be as a result of the fact that they are usually easier to set. The surprising thing however was that for chemistry, there were questions set by the two bodies at each of the levels of the cognitive domain and for all the years. It could be possible that mathematics, by its nature, is more amenable to questions at higher cognitive levels. The result also showed that in each year and for each subject, WAEC set more number of questions in mathematics in the level of higher order of thinking.

RECOMMENDATIONS

The findings from this study have revealed the need for counselors, teachers, psychologists and other stakeholders of education to take into account the variables considered in this study while addressing secondary school students' poor performance in mathematics.

Teaching Service Commission recruiting teachers into secondary school system has a significant role to play. The commission should make sure that professional teachers are recruited for teaching. They should also make sure that they are exposed to training programmes in the area of tests and measurement so as to know enhance students' academic

performance in mathematics.

To ensure high academic performance, competence, adequate and qualified teachers with teaching experience should handle the students' from JS 1 to SS 3. Students should be exposed to all areas of cognitive domain of test items to forestall poor performance in mathematics. If these were done, it would go a long way to enhance high academic performance and reduce examination malpractices in the nation's public examinations.

CONCLUSION

The urge to carry out this study was propelled by the fact that many students are failing mathematics year in year out and many researches had been carried out on factors responsible for it without any appreciable results on this. In the light of this, the researcher decided to see the area where the testees performed poorly with the hope that this would help in reducing the failure rate if the recommendations are implemented. This therefore called for a need to analyse the mathematics items used by WAEC in 2014 objective paper. This study took up the aspect of analysing how WAEC distributed their questions in mathematics paper across levels of the cognitive domain. Findings showed that in nearly all the situations, in the year 2014, there were more questions in the area of higher order thinking than in the lower order level of cognitive thinking. In conclusion, therefore, one would say that as far as the distribution of questions across the levels of the cognitive domain is concerned, WAEC has more items on higher order level of thinking than in lower order of cognitive level of thinking. Perhaps this is resulting in poor performance of the students and the students as they have not been exposed to higher level of cognitive domain.

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