TASK NUMBER AND COGNITIVE LEVELS AS DETERMINANTS FOR ITEM DIFFICULTY

Dr. Kingsley Chimah Obi[1]
Ugorji, Clifford Ph.D[2]

Department Of Primary Education Studies Alvan Ikoku[1&2]
Federal College Of Education, Owerri

Abstract

The paper addresses task numbers and cognitive levels as determinants of item facility indices. Task number is a new concept in item analysis and in conjunction with cognitive levels account for much item facility indices. Null hypotheses were rejected. The correlation coefficient between item facility indices and task number as well as that between item facility indices and cognitive levels were both statistically significant. The coefficient of multiple correlations between item facility indices on the one hand and task numbers and cognitive levels on the other hand is even more statistically significant. The paper therefore recommends that task numbers and cognitive levels should be given much consideration as determinants in item difficulty.

Key words: Task number, Cognitive level, Item difficulty.

Introduction

Concepts in multiple choice test item analysis that most people are familiar with include facility index, discrimination index and distractor index. Other psychometric properties of multiple choice test items worthy of consideration are: task numbers and cognitive levels of test items. Task number is a newly conceived psychometric property by Ogomaka (2011) not known to most people and has not been given much consideration.

Task numbers are steps of mental operations which are undertaken to successfully or accurately arrive to a solution to a given problem or task without counting/reckoning any step that has been already undertaken (Ogomaka, 2011). The testee undertakes sequential steps which enable him to perform a task of operation at hand. The person conducting the test expects that-each test follows some sequential mental operations to arrive at the correct answer to or solution of each test item. The number of distinct mental operations/process undertaken to arrive at the correct answer or solution of a test item is the task number of the item (Ogomaka, 2012).

Item cognitive level is known and credited to Bloom and his associates (1956). In most subject areas the Bloom's taxonomy of cognitive learning outcomes has six levels Viz: knowledge, comprehension, application, analysis, synthesis and evaluation. Most Mathematics educators (probably by the nature of Mathematics) are of the view that there are four levels starting from knowledge to analysis. The six levels or categories are welloutlined in Gronlund (1976) and Nwana

(2007). According to Nwanna (2007). The facility index (FI) of an item ranges from 0 to 1 and indicates the ease with which the item is got correct with respect to a given set of testes.

$$FI = \frac{n_c}{N}$$

where:

n_c = number of testees who got the item correct while N =number of testees who responded to the entire test. In some other situation, one may use the responses of the group of testees whose scores in the entire test constitute the upper one third (or 30%) and the group of testees whose scores also in the entire test constitute the lower one third (or 30%) of the scores of all the testees in the test. In such a situation

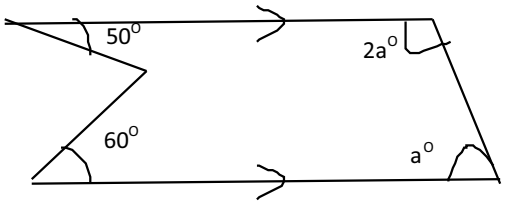
$$FI = \frac{n_u + n_c}{2n}$$

where

n_u = number of testees from the upper one third who got the item correct.
n_c = number of testees from the lower one third who got the item correct and n= the number that constitute one third (or 30%) of the testees.

Cognitive levels of test items are usually obtained from evaluation experts classifications or ratings of such items. Task numbers of an item is obtained by counting the number of distinct mental/ cognitive operations/steps involved in answering /working out/ solving the item correctly through the common/usual approaches (not through short cuts or approach more advanced them the group of testees), (Ogomala 2011). For instance the task numbers of the items:

(i) Multiple 132 by 3
(ii) What is the value of 132x5
(iii) Find x if 3x -5 =x- 7 and
(iv) Find the value of a in the diagram



The answers are got by answering the test items showing all details in each case,

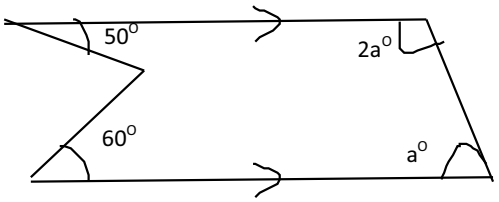
(I) 132
x 3
396 knowledge level 1

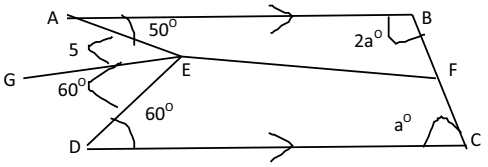
Here the testee: knows what multiply is and knows the multiplication table, since this involves two different steps in the mental operation, the task Number is 2 (ii)

(ii) 132
x 5 comprehension level 2
660

The testee: knows x stands for, multiply knows the multiplication table, knows how to "carry over and add", the task number is 4

(iii) $3X - 5 = X + 7$ (1)
$-X \quad -X$
$2X - 5 + 5 = 7 + 5$ (2)
$2X = 12$
$2X \div 2 = 12 + 2$ (3)
$X = 6$





EF IIel to AB and DC (construction).

AĖG = EĂB = 50° (Alternate angles).

GED - EĎC = 60° (Alternate angles).

In the pentagon ABCDE, sum of interior angles 2x5 (90^0)

540°

AĖD = 360° -110^0

= 250^0

50° + 2a + a + 60 + 250° = 540°

3a = 540° - 360°

= 180°

$a = \frac{180^0}{3} = 60°$

Also: EF IIel to ĂB and ĎC (construction)

GEA = EĂB (Alternate angles)

So AEF - 180° - 50°

GEB = DĈF (corresponding angles)

= a^0

In quadrilateral ABFE

50 + 2a + a 130° = 360°

3a+ 180° = 360

3a = 360° -180°

$3a = 180° \; a = \frac{180°}{3} = 60°$

The cognitive level is analysis level 4 while the task number is 9.

The testee knows rules guiding formal geometry, makes some construction, knows position of angles such as alternate and corresponding angles and the rules for using them. He carries out appropriate substitution, having earlier on carried out some additive and subtractive operations. The task number is 9.

Of course the determination of facility index of a test is based on the classical test theory (CTT). CTT stipulates that if A is better than B, then every item B gets correct, A must get it correct. There are items A will get correct and B will not get them correct (Ogomaka 2012). On the basis of that the facility index of an item is said to be group (of testees) dependent. However, as presented earlier, item task number and item cognitive level are not group dependent. Both are item dependent though not entirely objective. However, objectivity level may be improved by letting a number of experts to be involved in their determination. In such a situation a relevant measure of central tendency of the item task numbers or item cognitive levels assigned to an item by the experts will be an improvement. This situation is adopted in this study. The experts used here are five in number so the median of their rating scores to an item is used.

Statement of Problem: The importance of item analysis for proper achievement testing is accepted by all. But the determination of item difficulty estimate θ, using logistic curve of IRT is highly demanding. For an achievement test meant for a group of testees less than 1000 or even 2000, it is a Waste of time to and also not in conformity with the use of logistic curves. To determine the

properties of the test following the classical test theory CTT, would imply the use of a set of testees who are not members of the 2000 or 200 yet the determination of item properties through the CTT approach is faulted since such properties are said to be group dependent. Could the use of item cognitive level and the newly articulated task number tried out for a given set of test items be used to determine item difficulty? . Would such indices item cognitive level and task number correlate significantly with item facility indices of the given set of test items for the first stage of their study?
Would the same indices correlate significantly with, θ item difficulty index determined through logistic curve?

Scope of the Study

The area of Mathematics in which 50 multiple choice test items (MCtis) are set is geometry as well as algebra) of the junior secondary school (basic) mathematics.

Objective/Purpose of the Study

Generally, the study aimed at ascertaining the extent item cognitive levels and item task numbers correlate with item facility indices of a given set of mathematics multiple choice test items, (MCTIs), specifically the study ascertained:

i. The level of agreement (reliability) of experts in specifying item cognitive levels of mathematics MCTIs;

ii. The level of agreement among experts in specifying item task numbers (itns) of a given set of Mathematics MCTIs;

iii. The coefficient of correlation between facility indices (FIs) and Item cognitive levels (ICIs) of given Mathematics MCTIs;

iv. The coefficient of correlation between facility indices(FIs) and items task numbers itns.

v. The coefficient of correlation between item cognitive levels ICls and item task numbers itns.

Research Question

1. To what extent is the variation among item facility indices accounted for by the variation among task numbers of the same items?
2. To what extent is the variation among facility indices ofitems accounted for by the variation among the cognitive levels of the same items?
3. To what extent is the variation among test items facility indices accounted for by the variation among both the items task numbers and cognitive levels?
4. To what extent are the experts in agreement in assigning task numbers to the test items?
5. To what extent are the experts in agreement in assigning cognitive levels to the test items?

Null Hypotheses

Ho_1: The correlation coefficient between test item facility indices (TIFIs) and item task numbers (TIFIs) is not statistically significant (notstatistically different from zero), ($P < 0.05$).

HO_2: The correlation coefficient between test items faculty indices (TIFIs) and item cognitive levels ICLs is not statistically significant($P < 0.05$).

HO_3: The correlation coefficient of multiple regression between test item facility indices on the one hand and item cognitive levels (ICls) and item task

numbers (TIFIs) on the other hand are not statistically significant.

Significance/ Importance of the Study
The importance of item analysis for proper achievement testing as accepted by many is given consideration in this paper, the study hinges on working out item cognitive levels ICls and item task numbers itns and theextent the two correlate with test item facility indices tifis of a givers set of mathematical multiple- choice test items (mctis). The study is considered significant because: the result of the study will add to the existing bodyof knowledge on the extent item cognitive levels icls and item tasknumbers itns correlate with test item facility induces tifls of a giver set of mathematics multiple choice test items (mctis). The study highlighted the determination of test item facility indices tifis on test item cognitive levels ticls and test item task numbers titns. The study would help evaluators give required consideration to item cognitive level icls and item task numbers itns during item analysis of facility indices fls.

Design and Procedure:
The study is correlational. It involves simple linear correlation and multiple linear correlation.

Area of Study
The study was carried out in Isiala Mbano in Imo State.

Population
The population was made up of 96 students of JSS2 of the basic secondary education and the sample selected was 64 students.

Instruments for Data Collection
Multiple choice test item (MCtis) were developed and administered to the students. There are two sections, sections 1 and 2 each containing 25 items. Therefore in all there are 50 items.

Validation
The test items were validated by five experts of educational measurement and evaluation. The experts read through the items to ensure: the correctness of expressions, the appropriateness of the tasks/ exercises, and the correctness of the keys.

The experts individually assigned task numbers and cognitive levels to the respective items following the explanations /definitions of the two items characteristics using some statistics from a two way. Analysis of variance a s developed by Abel (1952) an inter-rater reliability coefficient of 0.79 is obtained for the five experts through a trial testing and using Kudder Richardson formula 20, the reliability coefficient of the test is found to be 0.80

Data Analysis and Results
Table 1: Correlation coefficient between task numbers X and cognitive levels Y.

Xy	$\sum x^2$	$\sum y^2$	r_{xy}
37.3608	50	48.6316	0.758

Table 2: Correlation coefficient between task numbers X and facility indices *Z.*

Xz	$\sum x^2$	$\sum z^2$	r_{xy}
-8.91893	50	1.940311	-0.906

Table 3: Correlation coefficient between cognitive levels Y and facility indices Z.

Yz	$\sum y^2$	$\sum z^2$	r_{xy}
-8.847	48.631	1.94033	-0.911

Table 4: Correlation coefficient between task number X, Cognitive levels Y and

r_{xy}	r_{xz}	r_{yz}	r^2_{xy}	r^2_{xz}	R^2_{yz}	$R_{Z.xy}$
0,758	-0.906	-0,911	0,5746	0.8208	0.8299	0.9690

Table 5: Testing of Hypotheses

		Sample Size (n)	tcal	t_{tab}	E_{cal}	F_{tab}	df	Decision
$\mathbf{r_{xz}}$	-0.906	64	14.83	2.01	-	-	63	Significant
r_{yz}	-0,911	64	15.30	2.01	-	-	63	Significant
$\mathbf{R_{Z.XY}}$	0.9690	64	-	-	279	1.13	63	Significant

Interpretation of Results

Correlation coefficients were used in data analyses. The hypotheses were tested and the research questions answered.

Discussion of Results

The results show that item difficulty is associated with both task numbers and cognitive levels, null hypotheses were rejected showing that the:

(i) Correlation coefficient between test item facility indices and task numbers of the item and

(ii) Correlation coefficient between test item facility indices and cognitive levels of the item are both statistically significant.

The results were high.

The coefficient of multiple correlation between item facility indices on the one hand and task numbers and cognitive levels on the other hand is even more statistically significant.

Answers to Research Questions

1. The extent to which the variation among item facilities is accounted for by the variation among task numbers of the same item is about 82.1%.
2. The extent to which the variation among item facility indices is accounted for by the variation among cognitive levels of the same items is about 83,0%,
3. The extent to which the variation among item facility Indices accounted for by the variation among both the task numbers and cognitive levels is about 93. 9%.

Implications of the study

The results of the findings show that both task numbers and cognitive levels contribute largely to the difficulty of a test item and should therefore be given much consideration when setting multiple choice test item (mctis) by evaluators.

Limitation

The result of the study was limited by some constraints. The researcher was unable to assess students in senior secondary school and also could not assess students in other areas than mathematics.

Conclusion

Task numbers and cognitive levels determine item facility indices. Task number is a new concept in item analysis, much consideration should be given to task numbers and cognitive

levels when item difficulty is being determined.

Recommendation

This paper recommends that this study be carried out in different subject areas at various educational levels and that task numbers and cognitive levels should be given much consideration by evaluators

References

Nwana, O.C. (2008). Introduction to Educational Research, Ibadan:HEBN Publishers PLC.

Nwara, O.C (2007). Educational Measurement and Evolutional, Owerri: Boma Way Publishers.

Nworgu, B.G (1991). Education Research: Basic Issues and Methodology, Owerri: Wisdom Publishers Ltd.

Ogomaka, P.M.C (2004) Inferential Statistics for Research in Education and Social Sciences, Owerri: Peace wise Systems and prints.