Mathematics Teachers' Perception of Difficult Concepts in Secondary School Mathematics Curriculum in Benue State, Nigeria

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Abstract - *This study was designed to investigate secondary school mathematics teachers' classification of concepts along the dimensions of difficulty level. Also, the intent was to study how mathematics teachers' cognitive views and conceptualizations influence their perception of mathematics learning items as either difficult or otherwise. Ninety-five mathematics teachers at the secondary school level were used for this study. The instrument spanned algebra, number and numeration, geometry, trigonometry and statistics. Further, the concepts included in the instrument were extracted from the West African Examinations Council's General Certificate in Education(GCE) O' level syllabus and the Nigerian Educational Research and Development Council (NERDC) secondary school mathematics curriculum. The result of the analysis performed on responses of the subjects involved in the study showed poor agreement in the classifications of the mathematics concepts. Agreement was slightly strong on only five items. It seems the mathematics teachers agree that a majority of the items are important but easy to learn and teach.*

Keyword: *Perception, difficult concept, curriculum, mathematics teacher*

INTRODUCTION

Mathematics is one of the core subjects in both junior and senior secondary school curriculum in Nigeria. Such inclusion justifies the recognition of mathematics as being essential, but the development in mathematics has not been very encouraging. Attempts have been made by researchers in mathematics education to deal with the problem of achievement in school mathematics. Several variables ranging from the learners themselves, the teachers, textbooks, the curricular, to the school environment, have been identified as contributing to poor student achievement in school mathematics.

A few of such studies dealt with the issue of teachers, textbooks and curriculum content, Makama [1] synthesized a number of investigations and their results. It was observed that the Nigeria mathematics teachers were not properly prepared to handler mathematics programmes which the teachers are expected to teach. Also, [2] studied the amount of time spent by teachers on 28 mathematics learning items in the Nigeria mathematics syllabus for secondary school students. The findings showed that the students in the study sample were given a "good exposure" but student's level of achievement on a test based on the items was very low. The researchers found that mathematics teachers always struggle to cover the content of the mathematics syllabus as prescribed by external examination bodies without regards to students' meaningful understanding of the content. In a similar vein, Nwangwu [3] investigated the perception of the Nigerian mathematics curriculum for secondary school students by teachers using four issues: (a) relevance of content (b) relevance of instructional objectives, (c) adequacy and balance of content and (d) feasibility of the prescribed teaching and learning strategies. Sixteen mathematics teachers and 24 pre-service teachers were involved in the study. The results showed that the two categories of teachers differed in their perception of the four curriculum matters. However Nwangwu [3]'s study did not yield an explicit result as to which aspects of the mathematics curriculum the teachers showed differences in their perceptions. Moreover, the researcher did not address the relationship between teacher's subject matter knowledge and the mathematics learning items they are to teach to students. That not with-standing, Makama [1] did point out the need to investigate the effect of mathematics teachers' knowledge on the delivery of mathematics knowledge in the classroom in Nigeria. He further suggested that the study of the

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characteristics of mathematics teachers and their attitudes to mathematics teaching should form a component of a research frame work for investigating curriculum problem and issues in mathematics teaching and learning.

Consequently, the focus of this study was on mathematics teachers at the secondary school level. As it has been conjectured that the amount of knowledge of mathematics possessed by the teacher, his/her perception of mathematics and attitude to work, are plausible variables which do impinge on students' achievement, it is pertinent to investigate how teachers of mathematics rate learning items in the school curriculum. Mathematics teachers' cognitive view of such items in mathematics may show the importance attached to them. Also, it may affect their choice of instructional strategies for teaching the concepts. In a nutshell, the mathematics teacher's comprehensive view of mathematics and the subject matter of mathematics may affect the teacher's pedagogical effectiveness.

Science educators in Nigeria have been making effort to identify difficult concepts in the secondary school science curricular. Achor et al., [4] investigated difficult areas in physics and [5] chemistry contents at the secondary school level. However, students were involved in the rating and categorization of concepts as difficult or easy to learn.

It has been shown that the views of learners usually are at variance with those of trainers or experts. In the present study, teachers of mathematics at the secondary school level were involved in the categorization of a list of concepts in mathematics along a scale patterned after that of Likert.

Mathematics teachers are the implementers of the mathematics curriculum for schools. They form proximal frame factor in the execution of the intended mathematics learning outcomes. This means that teachers could constitute a contextual constraint or resource for the effective teaching of mathematics. Also it follows that their own conceptualization of the items in the curriculum may influence their teaching. Thus, the purpose of this study was to investigate mathematics teachers' perception of some mathematical concepts which are taught to students at the secondary school level as either difficult or easy. It was assumed that a concept may be viewed as very important but may be difficult to teach to students. Likewise a concept may be perceived as easy to teach and may not be seen as important in the learning and teaching of mathematics. In addition, it was assumed that teachers would impose their own knowledge and conceptualization on the concepts.

The following research questions guided the study.

(1)To what extent would mathematics teachers perceived the mathematics contents as easy or difficult to teach and learn;

(2)To what extent would teachers' knowledge of the content influence their conceptualization of mathematics items to be learned and taught?

METHODS

The study was carried out in Benue State of Nigeria. Two hundred and five mathematics teachers at the secondary school level were involved in the study. Furthermore, the secondary school mathematics teachers spanned seventy-seven schools in the state. The average years of mathematics teaching experience was observed to be 5.8 years and the average teaching load in mathematics for the subject in the study sample was 20.5 periods per week. However, a large number of the teachers had less than four years of working experience at the secondary school level. In addition, it was observed that some returned copies of the instrument used for the study were not properly completed by the respondents. Coupled with such observations and the needed teaching experience in mathematics, the number of teachers in the sample was reduced to ninety five. Secondary school education spans six years in Nigeria and for a mathematics teacher to adequately address the items on the research instrument, he/she might have taught in the school for at least five years. It was as such conjectured that the subjects in this study sample had enough experience in the mathematics teaching and would competently respond to the items on the instrument. The teachers' judgments were treated consecutively and simultaneously along the dimensions of importance and difficulty. The research questions were used to make inference about how teachers deal with each topic or category of mathematics contact in the school curriculum.

The instrument used for this study was called Mathematics Content Survey Questionnaire (MCSQ). Four major mathematics curriculum categories (algebra, number and numeration, statistics and geometry with trigonometry) were on the instrument. Each macro content areas contained specific/micro content items. Number system contained 14 items, algebra 12 items, statistics had six items and geometry coupled with trigonometry contained 29 items because of the series of theorems and constructions to be

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learned by the students. In all, the instrument contained 61 mathematics learning items.

The mathematics micro items were selected from the Nigerian Educational Research and Development Councils (NERDC) new mathematics curricula for the junior and senior secondary schools. Furthermore, the researchers consulted the West African Examinations Council (WAEC) mathematics syllabus, in order to match the items with those examined by the council. It should be noted that several of the schools where the subjects were drawn relied squarely on the WAEC syllabus for teaching mathematics.

The items were to be rated along a two dimensional scale: Difficulty level and importance level. Each dimension has a five point sub-scale patterned after the Likert scale. Along the dimension of difficulty, it varies from easy to very difficult. Within the importance dimension the sub-scale ranges from unimportant to very important. A subject was asked to rate each content item on the instrument along the two dimension simultaneously. As an illustration, content item *X* may be rated as averagely difficult but very important along the dimension of difficulty and importance respectively.

A content validation of the instrument was carried out by experts in mathematics Education. This was done by comparing the items on the instrument with the items in the 2 tier (i.e. junior and senior secondary school) mathematics curriculum and those in the WAEC General Certificate of Education (GCE) Ordinary Level Mathematics Examination Syllabus. It was equally to ensure that items generated were adequately covered in all the concepts considered in this study.

The mathematics content survey Questionnaire was administered to the subjects of this study during the first term of the 2010/2011 academic year. The students offering an undergraduate research course in the department of curriculum and teaching, Faculty of Education in Benue State University, Makurdi assisted in the distribution of copies of the questionnaire. Thus students stayed with the subject to complete copies of the questionnaire and the same students returned the completed copies to the researchers.

RESULTS AND DISCUSSION

The major focus of this work was the investigation of the patterns of categorization of mathematics learning items or topics along the dimensions of difficulty and importance by secondary school mathematics teachers. In order to address this issue, analysis was done with the data collected from the mathematics teachers in the study sample. The result yielded four 5 × 5 contingency tables. It was observed many cells in the 5 x 5 contingency tables were either empty or had expected frequencies less than five. Because of the violation of the assumptions of the chi-square distribution and statistics, the cross-break was partitioned into a set of 2 x 2 contingency tables. The importance dimension was segmented into unimportant and important at the same time the difficulty axis was reduced to easy and difficult. The cross break analysis produced sixty-one 2 x 2 frequency matrices (one for each item on the instrument) as illustrated below.

	Easy	Difficult
Unimportant	A	B
Important	C	D

Letters a, b, c and d are the frequencies of responses obtained on either each learning item or topic or the sums of frequencies obtained per each aspect of mathematics at the secondary school level. A chi-square analysis was performed on the cross breaks with a further analysis which involved the use of the τ(tau) measure of agreement is denoted by:

$$\tau = \sqrt{\lambda} \quad -1 \leq \tau \leq 1$$

$$\text{and } \tau = \frac{x^2}{(c-1)N}$$

Where c stands for the number of columns and N for the total of the marginal frequencies. Moreover, if the sum of the observed frequencies in the diagonal is greater than the sum of the corresponding expected frequencies, τ is positive, if otherwise, τ is negative. As proposed by Obodo (2004) the following value of τ in an interval scale could be use to judge the strength of agreement.

τ Strength of agreement

0.00 – 0.20: Poor ; 0.21 – 0.40: Slight ; 0.41 – 0.60: Moderate; 0.61 – 0.80: Substantial; >0.80: Almost perfect . The given scale was used to determine the strength of agreement in the judgment of mathematics teachers in this study.

Number and Numeration: Fourteen items were selected for a categorization in number and numeration. The judgment of the mathematics teachers in the sample showed a slight agreement on item 5, approximately, and it is positive. There were poor agreements in their judgment of other 13 items. The chi-square and tau values for the items are very low and not significant.

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Table 1. Classification of number and numeration items with x^2 and tau values

Items	UIE	UID	IE	ID	N	λ^2	τ
Directed numbers	14	0	68	13	95	2.58	10.165
Number bases	32	2	48	7	89	1.03	0.106
Fractions	11	0	75	7	93	0.97	0.102
Decimals	17	3	63	7	90	0.42	0.068
Approximations	31	2	42	12	87	3.94	0.213
Indices	17	7	52	16	92	0.31	0.056
Logarithms	11	9	45	22	87	1.02	0.108
Squares	22	4	58	7	91	0.41	0.067
Square Roots	24	4	47	18	93	1.93	0.144
Reciprocal	19	14	38	10	91	1.66	0.135
Ratios	29	2	60	3	90	0.30	0.058
Proportions	25	0	56	15	90	2.69	0.173
Rates and means	16	5	51	14	86	0.06	0.026
Percentages	13	3	68	5	89	2.48	0.167

Key: UIE=Unimportant Easy; UID=Unimportant Difficult; IE=Important Easy; ID=Important Difficult.

The results indicated no agreement among the mathematics teachers in their judgment. The results of the classification are shown in table 1. Note that the results of the analysis done on the classification of items in algebra showed "poor agreement" among the teachers. The chi-square and tau values were very small as shown in table 2.

Table 2. Classification of Algebra items with x^2 and tau values

Items	UIE	UID	IE	ID	N	λ^2	τ
Symbolization	23	4	47	15	89	1.02	0.107
Interpretation of statements in symbolization form	14	7	29	30	80	1.90	0.145
Evaluation of Algebraic expression	18	11	43	17	89	0.86	0.098
Factorization	20	4	49	20	93	1.32	0.119
Change of Formula	17	8	44	23	92	0.04	0.02
Algebraic Fractions	22	7	38	22	89	0.47	0.073
Graphs of Algebraic Fraction	15	10	36	28	89	0.54	0.078
Solution of Linear Eqns	17	4	55	15	91	0.05	0.023
Solution of simultaneous Eqns	20	4	46	14	84	0.42	0.071
Solution of simultaneous linear and one quadratic Eqns	20	13	24	32	89	2.16	0.155
Quadratic Equations	13	5	32	31	81	2.60	0.179
Variations	18	11	22	23	74	1.21	0.128

Key: UIE=Unimportant Easy; UID=Unimportant Difficult; IE=Important Easy; ID=Important Difficult.

Table 3. Classification of Statistics and Probability Items with x^2 and Tau Values

Items	UIE	UID	IE	ID	N	λ^2	τ
Frequency distribution	19	4	59	8	90	0.41	0.067
Pie chart	14	7	60	9	90	4.66	0.228
Bar charts	20	4	63	4	91	2.55	0.167
Measure of central tendency	12	7	58	12	89	3.37	0.053
Histogram	17	10	41	19	87	0.24	0.053
Simple probability	28	1	42	11	82	4.370	0.230

Key: UIE=Unimportant Easy; UID=Unimportant Difficult; IE=Important Easy; ID=Important Difficult .

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Statistics and Probability: Six items in statistics/probability were given to the mathematic teachers in the sample to categorize. The teachers had slight agreements in their judgments on pie chart and histogram. There were no agreements on the other four items (frequency distribution, bar charts, simple probability and measures of central tendency). The results of the chi-square and tau value are presented in table 3.

Plane Geometry: The mathematics teachers in the study sample had a slight agreement in their judgments on definition and congruency. There was a poor agreement on the remainder of the items under plane geometry. The value of the chi-square and tau are very small as contained in table 4.

Table 4. Classification of Plane Geometry Items with x^2 and Tau Values.

Items	UIE	UID	IE	ID	N	λ^2	τ
Definitions	20	3	41	15	89	4.08	0.214
Theorems	15	8	30	37	90	3.50	0.197
Proofs	12	16	15	46	89	3.03	0.185
Construction	11	5	43	29	88	0.45	0.072
Triangle	24	4	48	14	90	0.84	0.097
Quadrilaterals	22	9	43	14	88	0.38	0.066
Similarity	19	5	36	24	84	2.81	0.183
Congruency	20	5	41	18	84	0.92	0.105
Trig. Ratios	19	4	31	30	84	6.98	0.288
Circles	18	7	45	18	88	0.00	0.058
Angles of elevation	16	4	46	23	89	1.23	0.118
Angles	20	5	47	9	81	0.20	0.050
Bearings	10	5	36	38	89	1.54	0.132
Volume/spheres/cones	11	9	32	30	82	0.07	0.029
Area of triangle/circles	12	11	38	30	91	0.09	0.031
Sectors	10	26	20	30	86	1.43	0.129
Pyramids	13	21	21	27	82	0.25	0.055
Spheres	8	28	19	27	82	2.96	0.190
Tetrahedron	16	12	38	27	90	0.14	0.039
Cuboids	17	4	53	12	86	0.01	0.008
Bisection of angles	24	2	54	10	90	1.07	0.109
Locus	13	14	28	34	89	0.08	0.030
Parabolas	9	9	33	38	89	0.07	0.028

Key: UIE=Unimportant Easy; UID=Unimportant Difficult; IE=Important Easy; ID=Important Difficult.

The major findings of this study was that the mathematics teachers in the study sample showed a weak agreement in their judgment of only five of the mathematics learning items presented in the questionnaire. There was almost no agreement in their categorization of the remaining 56. A close look at the chi-square and tau values for items 5 (approximation) revealed that the mathematics teachers agreed that the item is easy but important to be learned by students. The same judgment holds for items 28 (pie chart) 32 (histogram), 33 (definitions in plane geometry), but there was a division of the classification of item 41 (congruency). It seems that the teachers agreed that the item is important to be taught to students but it would be easy or difficult to learn and taught by mathematics teachers. The difficulty level rating might depend on the subject matter, knowledge of the teacher or the type of students that the teachers have in their mathematics classes.

Another look at the table reveals that the teachers rated a large percentage of the learning items as important but easy to learn and teach to students, though their agreement on such judgment was poor. This implies that the mathematics to all level involved in the study had more or less the same cognitive view of the learning items. The poor agreement might be due to the variations in the mathematics teacher teaching experiences. [6] Did show this in his work. More experienced mathematics teacher exhibited better subject-matter knowledge than novice mathematics teachers. In this study, 35.8% of the mathematics teachers had only five years experience in the teaching of mathematics at the secondary school level. Another 35.8% had between 7 and 10 years, 19% between 11 and 15 years and 9.4% between 16 and 21 years of mathematics teaching.

CONCLUSION AND RECOMMENDATION

The academic background of the individual mathematics teachers in terms of exposure to mathematics courses during their training as teachers, the type of training programs and the emphasis placed upon subject matter contents of mathematics might have contributed to the poor strength of agreement exhibited by some of the mathematics teachers. Mathematics teachers' programmes in Nigerian universities vary from one to another. However, with the new dispensation by the government, the programmes are being harmonized in order to give similar trainings to pre-service teachers. The use of in-service programmes, teacher vacation courses and workshops may help to reduce the difference in cognitive reviews and levels of subject matter knowledge among mathematics teachers. If the differences are not reduced to a manageable level, the failure rates which vary from school to school and state to state may continue. If groups of learning items in mathematics are perceived as important but difficult

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to learn and teach, it follows that mathematics teachers may not teach such items. Many mathematics teachers may completely avoid such topics. The consequences are always revealed by the performance of students in externally conducted examinations in mathematics in Nigeria. Since the results of this study are not very conclusive, more evidences are needed in terms of the actual performance of the mathematics teacher in the classroom. A study similar to this will suffice. Such a study may expose the impact of mathematics teachers' cognitive views on their teaching along with their subject matter knowledge.

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