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Full Length Research Paper

Impact evaluation of Further Mathematics curriculum in Nigeria

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This research was a perceptual survey study carried out to determine whether the goals of Further Mathematics Curriculum (FMC) are being achieved at the Senior Secondary School level. The sample for the study consisted of 240 FM final year students, 45 FM teachers and 180 undergraduates who were selected by a multi-stage stratified random sampling technique from Rivers and Imo States of Nigeria. One research question was posed and three hypotheses formulated. Data for the study was gathered using three questionnaires. Analysis was done using descriptive and inferential statistics. Findings of the study showed that the respondents scored the instructional strategies of the FMC implementation below average. The results further revealed that students have a poor perception on the mode of evaluation practices in FM classrooms and that 57.8% of the students expressed doubt on good content coverage of the FM. One encouraging result, however, is that the respondents agree that the goals of the FMC are being achieved. The authors recommend that a special monitoring unit be set by governments to ensure strict adherence to all the instructional strategies advocated in FMC implementation guide lines.

Key words: Further mathematics, curriculum, evaluation, perception, goals and adherence

INTRODUCTION

The curriculum evaluation of educational system and its products has become a discipline in its own right in the last forty years. Further Mathematics Curriculum (FMC) evaluation as the title implies, has two related concepts: Curriculum and evaluation. Curriculum has been defined in many different ways by experts. According to Maduewesi (1987), curriculum is defined as "the sum total of what the students learn at school and what the teachers do at school from the day the students are admitted to when they leave". But Tanner and Tanner (1965) cited in Mkpa (1987) have argued that "Such broad definition must be regarded as untenable". Beauchamp (1972) defines curriculum as a document designed to be used as point of departure for instructional planning. Thus FMC is a curriculum document, published complete with a philosophy, a set of goals, some selected mathematics contents, some pedagogical specifications and, some necessary evaluation prescriptive suggestions for its interpretation.

The concept of evaluation in an educational endeavour provides the basis for judgment about an educational programme. Evaluation is defined as the collection of information to make decision about an educational programme (Cronbach, 1973). But, Beeby's (1973) definition of evaluation as the systematic collection and interpretation of evidence leading, as part of the process, to judgment of value with a view for action are more relevant to us in this paper. In fact, evaluation should prompt action. Curriculum evaluation, therefore, is viewed as a systematic examination of events occurring in and consequent of contemporary programme on examination

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conducted to assist in improving the programme and other programmes having the same general purpose. Simply put, Abimbola and Mustapha (2000) see curriculum evaluation as the systematic collection of information on all aspects of an educational programme or its component with a view to facilitate decision making about the worth of the curriculum and whether or not the curriculum goals and objectives are capable of being achieved.

From the aforementioned, we see curriculum evaluation as a quality control mechanism of educational programmes and processes by which we clarify and substantiate the effectiveness of our objectives, learning experiences and content. Nworgu (1991) has observed that in developing countries such as ours, this function of curriculum evaluation as a quality control mechanism is yet to be met. Even in the developed countries the story may not be different as Wrigley (1968) cited in Harbour-Peters (1993), observed that the pattern of curriculum development in United States and United Kingdom has been one of act of faith and trial and error.

Emergence of FMC

Further mathematic is relatively a new curriculum in Nigerian Educational System. Its introduction into the school curriculum was one of the recommendations of a national workshop on policies and strategies for the improvement of the teaching and learning mathematics at all levels organized by the National Mathematics Centre (NMC) (Badmus, 1997). A decision at this workshop among others was that there should be two parallel mathematics classes or streams at the secondary school level: the Senior Secondary School Mathematics Curriculum (SSMC) and Further Mathematics Curriculum (FMC). This decision was based on the critical issues raised on the insufficiency in the extent of coverage of the draft of New General Mathematics Curriculum (1978). Furthermore, it was strongly felt that there is need to teach a meaningful mathematics that would offer something to different kinds of students vis-à-vis those who would and those who would not use mathematics in their later studies or profession (Odili, 2006).

Before the new mathematics curricula, there existed the additional mathematics syllabus, which is almost a disjoint of the general mathematics syllabus. It was also evident that the then mathematics syllabi (General Mathematics and Additional Mathematics) failed to provide the link between secondary school mathematics and tertiary mathematics courses (Ogoamaka, 1990). The 1981 Mathematics Curricula Critique Workshop at Onitsha made a case for a mathematics curriculum that would take care of the above deficiencies. The final draft of the FMC for Senior Secondary Schools (SSS) was produced during a subsequent critique workshop held in Jos in 1983. Consequently, FMC came to be after its official publication in 1984. The FMC has remained in the implementation phase for more than two decades (since September, 1985). In contrast, the present General Mathematics for the SSS is subsumed in the FMC.

Performance trend in FM

The above efforts were to improve the learning of mathematics. Yet the rate of failure in FM remains high. The chief examiners report of the May/June, 1998 on Further Mathematics examination also lends credence to students' poor performance. The report noted that like in General Mathematics, there were evidences to show that most of the candidates did not have enough practice and did not cover the syllabus before attempting the examination. They failed to demonstrate thorough understanding of various concepts and principles not to think of applying them in solving problems. It is instructive to note that the Chief Examiner's Report (WAEC, 2000) had pointed out that there was the need to prepare candidates better on questions dealing with vectors and mechanics, noting that this is the fundamental basis for technological advancement (NERDC, 2002).

This trend of poor academic performance in Further Mathematics has created a shortfall in the number of qualified candidates required to fill the quota for mathematics and mathematics-oriented courses in our universities (Abdulraman, 1992). As the low level of mathematics achievement has become an issue of grave concern, the necessity of investigating possible causes becomes more urgent. Several factors have been responsible for the high failure rate in Mathematics at the Secondary School level in recent years. These factors include attitude of students and teachers (Lassa, 1984; Ale, 1989); content difficulty (Harbour-Peters, 1992; Obioma, 1992; Adebayo, 1999); instructional techniques (Obioma and Ohuche, 1986) and quantity and quality of teachers (Badmus, 1989, Sule, 1991).

Two features that seem to point to ineffective implementation of the FMC are the low institutional enrolment figures in Further Mathematics (Ezeilo, 1988; Adebayo, 1999; Oragwam, 2000) and the poor performance of a very large majority of senior secondary students in Further Mathematics papers of West African Examination Council (WAEC) and National Examination Council (NECO) (Adebayo, 1999; Oragwam, 2000). The problem arising from the lack of preparatory efforts is further compounded, by the evidence established by Obioma (1992) to the effect that Senior Secondary Mathematics teachers identified some mathematics topics as very difficult to teach. Harbor-Peters (1992) also found out that graduating SSS students were deficient in all the concepts of Further Mathematics except in indices and logarithm. The other related important dimension is that Junior Secondary School (JSS) students who eventually proceeded to the SSS performed poorly

in the Junior Secondary Mathematics (Obioma and Ohuche, 1984; Lassa, 1986; Odili, 1986; Obioma, 1988). The ensuing implication is that since the Junior Secondary Mathematics forms the basis for the further pursuit of the subject, students' achievement patterns may follow a similar trend.

These problems, taken together, provide a fundamental motive for the present investigation. As Adebayo (1999) succinctly put it, "in order to ensure that good teaching and learning activities take place, there is need for continuous evaluation of the Further Mathematics Programme". Gbamanja and Efebo (1996) had asserted that the evaluation systems and processes in Nigeria had been a major cause of our education maladies and a stumbling block to meaningful educational achievement. It is pertinent to note that, the National School Curriculum Committee (FME, 1991) had, as a major issue, drawn attention to lack of adequate research studies on problems of mathematics teaching and learning in schools including evaluation of existing mathematics curricula. The committee therefore recommended that research studies on mathematics teaching and learning problems should be vigorously pursued in order to proffer solutions to identified problems. In this connection, the existing mathematics curriculum should be evaluated for purpose of improvement, if necessary. To the best knowledge of the writers, not much study had been carried out on the evaluation of FMC about twenty-five years after its introduction in the SSS in Nigeria. The present study therefore, evaluated the implementation status of the FMC more especially the extent to which the objectives of the FMC had been attained in Nigeria. The present study was therefore designed to explore this from the perceptual assessment of FM students, FM teachers and undergraduates of science related courses in Imo and Rivers State of Nigeria.

Statement of the problem

For the study of Mathematics to attain practical significance and high utility in a society aspiring for rapid scientific and technological advancement, it has to be pursued well beyond the basic or general level. No doubt, the FMC was introduced in Nigerian SSS in the honest hope that it was a good and timely response to certain educational career and general needs of the science-bound students and the society. This expectation implies that the implementation of the FMC has to be maximally effective in the Nigeria Senior Secondary Education System.

One of the compelling questions that have often emerged with regard to introducing new curricula materials in schools concerns the effectiveness of the new materials in enabling students attain the objectives of instruction through using the particular curriculum materials. One would like to know the extent the objectives of the FMC are being attained twenty-five years after it was introduced. Thus, the problem of the study posed as a question is: To what extent are the SSS students taught mathematics using the FMC attain the objectives of these curriculum materials? More specifically, the study addressed the following research question and hypotheses.

Research question

What are the patterns of FM students perception in terms of instructional strategies, achievement evaluation practices and FM topic coverage?

Hypotheses

H_{01}: There is no significant difference between the perceptions of male and female undergraduates as to the extent of assistance FM is in science-related courses.

H_{02}: There is no significant difference between the perceptions of FM teachers and undergraduates on the extent FMC prepares potential mathematicians, engineers and scientists.

H_{03}: There is no significant difference on the evaluation procedures utilized in the teaching of FM as perceived by the FM teachers and FM students.

METHODOLOGY

Research design and evaluation model

This study adopted an ex-post-facto research design. The appropriateness of this design lies in the fact that the FMC had been implemented before the study. As a theoretical framework to guide the present study the context, input, process and product (CIPP) (Stufflebeam, 2002a, 2003a, Stufflebeam et al., 2002) and context and outcome (Badmus, 1990) models of evaluation were adopted (Figure 1). Curriculum evaluation is usually guided by evaluation models (Shadish et al., 1995). The aim of CIPP model of curriculum evaluation is to provide information for the improvement of a curriculum or an aspect of a curriculum. But in context and outcome model attempt is made to reduce the CIPP four dimensions to two since the study focuses on the goals of FMC as context variable and the effective measures of recipients of the FMC as the outcome variable (Figure 1). The emphasis in this approach is on specifying the goals and objectives and determining the extent to which they have been achieved. Any discrepancy between the performance and the goals would lead to modification intended to correct the deficiency. This study is therefore an attempt to provide empirical data on the extent to which some expectations have been met in the introduction of the FMC in Nigeria.

Sample

A multi-stage stratified random sampling was employed in selecting four Public Senior Secondary Schools, one Federal Government College and three Private Senior Secondary Schools from each of

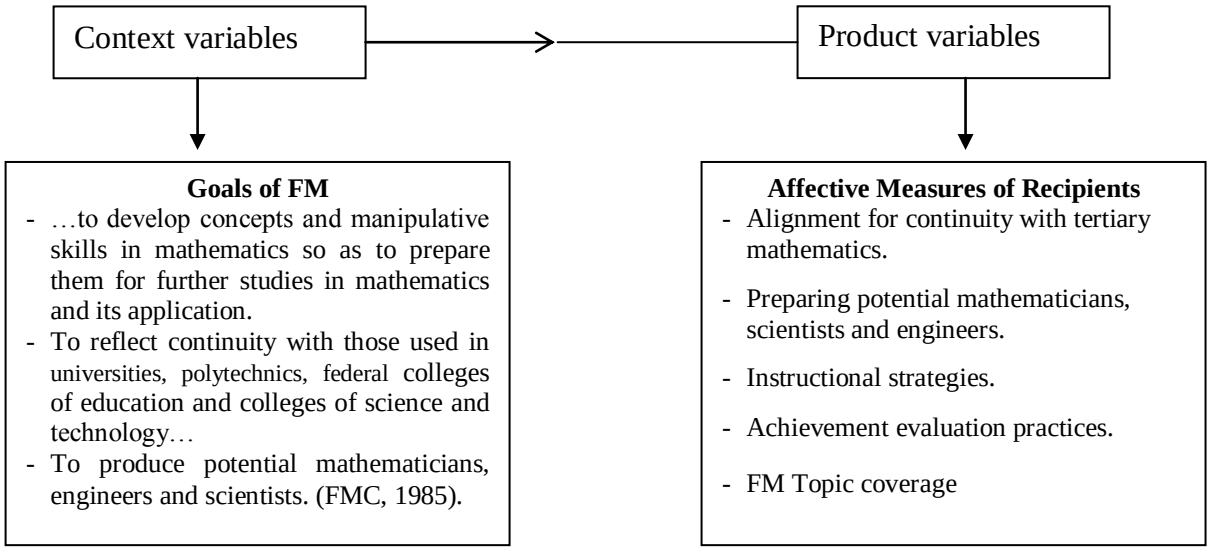

Figure 1. Adopted from Stufflebeam's CIPP model (1971) and context and outcome model (1990).

the two states in the study area. Fifteen FM students were randomly selected from each of the sixteen schools. Ten undergraduate students of science-related courses from first and second years respectively were randomly selected from each of the following tertiary institutions in the study area namely: Imo State University, Owerri; Federal University of Technology, Owerri Nigeria; Rivers State University of Science and Technology, Nkpolu Nigeria; Rivers State Polytechnic, Bori Nigeria; Rivers State College of Education, Rumuolumeni and Federal College of Education (Technical) Omoku Nigeria. On the whole, 240 FM final year students, 45 FM teachers and 180 undergraduates were involved in the study.

Research instrument

Three valid and reliable research instruments; FM Students Opinion Survey (FMSOS), FM Teacher Opinion Survey (FMTOS), and Undergraduate Opinion Survey (UOS) carved out from FMC implementation questionnaire developed by the researcher. A panel of experts (one university professor and three mathematics educators) analyzed and grouped the Lickert-type 36 statements into four categories:

(a) Instructional strategies (six items 1-6).
(b) Achievement evaluation, practices (six items 7-12).
(c) FM topic coverage (eighteen items 13-30).
(d) Preparing mathematicians, engineers and scientists (six items 31-36).

FMSOS was made up of 30 items from a, b and c categories. A reliable index of 0.85 was found by using Kuder-Richardson Formula 20. FMTOS was made up of 30 items of b, c and d with reliable index of 0.82. UOS was made up of 14 items of c and d. with reliable index of 0.81. Category c in this case sought to know to what extent the following topics were of assistance in the university programme.

Method of data analysis

Both descriptive and inferential statistics were used to analyze the data. The analysis was done with the aid of SPSS/PC. The research question was answered using frequency counts and percentages of subjects selecting each scale point were computed. The actual values of the subject responses were dichotomized into positive and negative perceptions. A value of 1 or 2 points connotes negative perception for each item, while a value of 3 or 4 points connotes positive and perceptions. This way, the frequency and percentage of subjects that exhibit negative positive perceptions for each item was determined. The hypotheses were analyzed using independent t-test statistics at 0.05 level of significance.

RESULTS AND DISCUSSION

The results and discussion of the study are represented in line with the research question and hypotheses.

Research question

What are the patterns of FM students' perception in terms of instructional strategies, achievement evaluation practices and FM topic coverage?

Data (Table 1) for answering the research question were expressed in terms of frequencies and percentages of positive and negative responses of students on each item. The indicators of curriculum implementation were thus subdivided into three subscales – instructional strategies, achievement evaluation practices and FM Topic coverage.

On instructional strategies, about 70% of them responded negatively that the instructional strategy of FM was low, while 84% of the students pointed out that they feel students copy and memorize solutions to problems for examination purposes. Moreso, 72.1% indicated that inquiry/discovery strategies were not predominant, while 70% agree that lecture method was dominant in the

Table 1. Patterns of FM students' perception.

	Items of sub-seales	Positive (F)	Response (%)	Negative (F)	Responses (%)
	Instructional Strategies:				
	(1) I will rate the teaching of FM very high..	72	30	168	70
	(2) Students copy and memorize solutions to problems for examination purposes.	84	35	156	65
	(3) Ideas and suggestion of students are sometimes accepted and built into teaching procedures.	120	50	120	50
A	(4) Inquiry/discovery strategies are predominant in the implementation of the FMC.	67	27.9	173	72.1
	(5) Lecture method is the predominantly used.	168	70	72	30
	(42) Examples are always related to real life situations.	48	20	192	80
	Average %		38.8%		61.2%
	Achievement evaluation practices:				
	(6) Enough time is given to essay tests.	96	40	144	60
	(7) The FM teacher uses only objective tests.	144	60	96	40
	(8) Take-home assignments are not marked.	60	25	180	75
B	(9) Class exercises are promptly marked.	48	20	192	80
	(10) Project/library work are never given.	36	15	204	85
	(11) Questionnaires are never used as a method of testing FM.	52	21.7	188	78.3
	Average		30.3		69.7
	FM topic coverage:				
	The following FM topics were well covered:				
	(12) Coordinate geometry	144	60	96	40
	(13) Trigonometric ratios	122	50.8	188	49.2
	(14) Algebraic equations	168	70	72	30
	(15) Polynominials	139	57.9	101	42.1
	(16) Partial fractions	120	50	120	50
	(17) Mapping operations	115	47.9	125	52.1
	(18) Integration	48	20	192	80
	(19) Differentiation	60	25	180	75
C	(20) Mathematical analysis (real, complex, vector, etc.).	84	35	156	65
	(21) Matrices and determinant	36	15	204	85
	(22) Sequences and series	72	30	168	70
	(23) Vectors	102	42.5	138	57.5
	(24) Dynamics	108	45	132	55
	(25) Measure of location	144	60	96	40
	(26) Measure of dispersion	120	50	120	50
	(27) Correlation		26		
	(28) Permutation and combination	72	30	168	70
	(29) Probability.	108	45	132	55
	Average		42.2		57.8

implementation of the FMC. Taken together, the picture shows that the respondents scored the instructional strategies of the FMC implementation below average. This may be due to lack of quality teachers. It dictates a need for adoption of uniform instructional strategies by adhering strictly to all the instructional strategies

Table 2. t-test analysis on the extent of assistance of FM in Science-related courses as perceived by male and female undergraduates.

Sex	n	Mean	SD	t-Cal	t-critical
Male	118	75.93	8.57		
Female	62	76.18	6.51	NS 0.20	1.96

Table 3. t-test analysis on preparation of potential mathematicians, engineers and scientists as perceived by FM teachers and undergraduates.

Variable	n	Mean	SD	t-Cal	t-Critical
FM teachers	45	72.73	6.73		
Undergraduates	180	71.86	5.58	NS 1.22	1.96

Table 4. t-test analysis on the evaluation procedures utilized in teaching FM.

Variable	N	Mean $\bar{\chi}$	Standard deviation	t-Cal	t-Critical
FM teachers	45	50.96	5.46	*S	1.96
FM Students	240	43.28	12.36	4.14	

*S = significant at 0.05 level.

advocated in the FMC document.

On the aspect of achievement evaluation practices, 60% of the students said that enough time was not given to Essay tests, while about 60% said that the FM teachers use only objective tests. About 80% of the students disagree that class exercises are promptly marked, whereas 75% of them agree that take-home assignments are not marked. On the whole, an average of 30.3 and 69.7% for positive and negative responses, respectively, were obtained on the level of achievement evaluation practices. This implies that about 69.7% of the students have a poor perception on the mode of evaluation practices in FM classrooms. A summary of the responses on the FM coverage, 57.8% of the students expressed doubt on good coverage of the FM contents. This again may be as a result of the difficulty of FM contents as expressed by FM teachers (Obioma, 1992).

Hypothesis 1

There is no significant difference between the perceptions of male and female undergraduates as to the extent of assistance FM is in science-related courses. Table 2 provides the means and standard deviations for male and female undergraduates. The t-calculated value is less than the t-critical values, which means that there is no significant difference between the perceptions of male and female undergraduates on the assistance of FM in the understanding of science-related courses. This finding is not surprising for as Ogoamaka (1990) had noted, the FMC caters for students with varying aptitudes and aspiration. Comparing FMC and the contents of the first year mathematics courses offered by students of Nigerian Colleges of Education, Colleges of Science and Technology, Polytechnics and Universities, Ogoamaka (1990) had observed that there are very few to no topics that are not treated in Further Mathematics. The consensual view of male and female undergraduates on the potential assistance of FM in science-related courses, is, therefore, not unexpected.

Hypothesis 2

There is no significant difference between the perceptions of FM teachers and undergraduates on the extent FMC prepares potential mathematicians, engineers and scientists. Table 3 shows the mean perception and standard deviation of FM teachers and undergraduates on adequate preparation of potential mathematicians, engineers and scientists. Since the two means (72.73 and 71.86) were above 50, the two respondents considered the FMC capable of achieving its goal of preparing potential mathematicians, engineers and scientists. With the t-calculated value of 1.22 less than the critical value of 1.96, the null hypothesis that there is no significant difference between the perceptions of FM teachers and undergraduates as to the extent FMC prepares potential mathematicians, engineers and scientists is not rejected.

Judging from the mean perceptions of the two categories of respondents, that is FM teachers with a mean of 72.73 and the undergraduates with a mean of 71.86; it could be inferred that both agree that FMC prepares potential mathematicians, engineers and scientists. Although their mean ratings are slightly different, t-test analysis showed that they are not significant. This means that both FM teachers and undergraduates have the same conviction about the potential of FM curriculum in the realization of its goals. A possible explanation for this is that both the FM teachers and the undergraduates have had a taste of FM teaching and learning. It is therefore not surprising that they hold similar views.

Hypothesis 3

There is no significant difference on the evaluation procedures utilized in the teaching of FM as perceived by the FM teachers and FM students. Table 4 shows that the mean perceptions of FM teachers and FM students were 50.96 and 44.12, respectively, indicating a little

difference. To establish whether this difference is significant, a t-test analysis was applied. Table 4 shows a t-test analysis on the evaluation procedures utilized in teaching FM.

The calculated t-value (4.14) is greater than the table (critical) value of 1.96. This means that there is a significant difference on the evaluation procedures utilized in teaching of FM as perceived by the FM teachers and students. That a significant difference exists between the perceptions of FM teachers and students on evaluation procedures is not surprising. Teachers as implementers of the curriculum are more knowledgeable than the students on the diversity of evaluation procedures used in FM implementation. This perhaps explains the significant difference in their perceptions.

CONCLUSION AND RECOMMENDATIONS

Mathematics curriculum reforms began with criticisms of the dull and uninteresting manner in which mathematics and additional mathematics were taught. But while the reformers deplored the poor teaching methods used, they developed the FMC that required special teaching strategies. Results from this study shows that a lot has to be done to improve the instructional strategies, achievement evaluation practices and content coverage of the teaching and learning FM. The result that male and female undergraduates have mean perceptions of 75.93 and 76.18, respectively, with t-test analysis indicating no significant difference shows that FM is of assistance to the products of FMC in science-related courses. Similarly, both FM teachers and undergraduates have high perceptions on the extent FMC prepares potential mathematicians, engineers and scientists. However, FM teachers and students differ on their perceptions on the evaluation procedures utilized. The fact that respondents agree that FM is achieving its goals; calls on government to improve the implementation of the FMC, by employing qualified teachers to teach FM. Based on the findings of the study, the following recommendations are made:

(1) A special monitoring unit should be set by both the Federal and State governments to ensure strict adherence to all the instructional strategies advocated for FMC implementation.
(2) Government should also organize workshops (the likes of the Teacher Vacation Course (TVC) of the 80's) targeted making them teach FM topics more effectively and confidently.

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