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THE DEVELOPMENT OF A MODEL PROGRAM FOR INSERVICE MATHEMATICS EDUCATION OF PRIMARY SCHOOL TEACHERS IN WESTERN STATE, NIGERIA

Dissertation for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
'BUKUNOLA MABOGUNJE OSIBODU
1975

This is to certify that the

thesis entitled

THE DEVELOPMENT OF A MODEL PROGRAM FOR INSERVICE MATHEMATICS EDUCATION OF PRIMARY SCHOOL TEACHERS IN WESTERN STATE, NIGERIA.

presented by

Bukunola Mabogunje Osibodu

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Education

Calhoun C. Collier
Major professor

Date July 24, 1975

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ABSTRACT

THE DEVELOPMENT OF A MODEL PROGRAM FOR INSERVICE MATHEMATICS EDUCATION OF PRIMARY SCHOOL TEACHERS IN WESTERN STATE, NIGERIA

By

'Bukunola Mabogunje Osibodu

This study had two major purposes. One was to survey the provision of inservice mathematics education for primary school teachers (grades 1-6) in the Western State of Nigeria, in order to identify the needs of primary teachers for mathematics teaching, and to investigate the views and preferences of teachers, headmasters and organizers on inservice mathematics education. The second was to develop a model for a systematic inservice mathematics education program based on the survey findings and other research results.

Utilizing a framework for inservice mathematics components, developed through a review of literature, three sets of questionnaires were designed and sent to a sample of Western State, Nigeria, teachers, headmasters and organizers respectively. The results of the questionnaire study, the review of literature on inservice mathematics education patterns and practices, and the Nigerian governmental publications on mathematics curriculum reforms gave direction for the development of a model for inservice mathematics education. A return of 95 percent, 100 percent and 40 percent of responses was obtained from 400 teachers, 80 headmasters and 5 organizers respectively.

Upon analysis, the data supported the following conclusions:

1. Elementary school teachers in many countries can and do benefit from a variety of inservice programs in mathematics and in other aspects of the curriculum.
2. A systematic long-sustained inservice program is likely to be more effective than a concentrated once-a-year program.
3. A majority of teachers (85%) in the Western State sample had never participated in inservice mathematics education programs.
4. Teachers realized their inadequate mathematics background, due mainly to poor preservice training, and were willing and ready to participate in an inservice mathematics program in order to upgrade their mathematical knowledge and for better mathematics teaching.
5. The most commonly expressed views on inservice mathematics training by all respondents were that: (a) the program should extend to all teachers, (b) it should be long-sustaining, (c) learning experiences should be through a practical approach with adequate provision for instructional materials, (d) appropriate evaluation should be planned, and (e) teachers should be remunerated accordingly.
6. The differences in the responses of different subgroups of teachers were not significant except in: (a) the responses of lower and upper primary teachers in their choice of the topic -- Solid geometry -- as

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a mathematical topic for inservice training, and (b) male and female teachers on "family responsibility" as a possible deterrent to participation in inservice mathematics programs.

A model for inservice training of primary school teachers was developed. A two-week concentrated course during the long vacation followed by seven one-day course during the school year was proposed. Major components of the model included: (a) the establishment of inservice objectives, (b) the selection of inservice learning experiences, (c) the organization of inservice programs, and (d) a plan for inservice evaluation.

On the basis of the findings and the requirements for model implementation, the following recommendations were made:

1. A Central Inservice Coordinating body with representatives from the government, the teacher training institutions, the professional organization, and the community should be established in the state.
2. Decision-making on the evaluation of systematic inservice programs and on the promotion procedures of primary teachers based on performance criteria was suggested.
3. Material production centers should be established in the state for the design, testing and mass production of instructional materials.
4. Quality inservice education should be an integral part of primary school mathematics teaching, as well as other aspects of the primary curriculum.

THE DEVELOPMENT OF A MODEL PROGRAM
FOR INSERVICE MATHEMATICS EDUCATION OF
PRIMARY SCHOOL TEACHERS IN
WESTERN STATE, NIGERIA

By

'Bukunola Mabogunje Osibodu

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

College of Education

1975

Dedicated

to

All Nigerian Primary School Teachers

who, with the support of the whole community,

must face the challenge of quality instruction

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I am indebted to the Dean of Faculty of Education, Univer-
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CHAPTER I

INTRODUCTION

The contemporary movement for the reform of both content and methodology in the teaching of mathematics at all levels of education affects the developing countries just as much as countries of Europe and North America. Indeed, in many ways, the reform raises more acute problems for the developing countries whose resources, in particular human resources, are very limited.

The reform has presented various challenges to school teachers, especially at the elementary level. These teachers need to acquire sufficient background in mathematics to enable them to provide effective instruction in the mathematics programs suggested for the elementary school. Recognizing the need for programs which would help the elementary school teachers meet the challenge of re-education in mathematics, many countries continue to initiate and implement different forms of inservice programs in this discipline. These attempts have led to increasing awareness of greater needs for the continued educational growth of teachers in the area of mathematics. Curriculum workers continue to have deeper insight into the connections between the course of study or a program of instruction in mathematics and the human teacher who translates their ideas into reality. A pronouncement made jointly by four professional c

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professional organizations in the United States succinctly summarized this awareness:

> Planning for a changing mathematics curriculum should provide for continuous inservice education of teachers both in mathematics content and in methods of mathematics instruction. The mathematics program not only has changed but will continue to change. The changing nature of the program results in a need for continuous inservice education. Teachers are increasingly recognizing that change is in the nature of current curriculum development, and that their tasks as teachers will constantly change in the years ahead. Ample time and help should be provided so that classroom teachers can remain alert to these changes. Many teachers, particularly at the elementary school level, have fears about their ability to understand and teach mathematics. An adequate inservice program helps overcome this fear.[1]

The implications of this situation are vast for educational institutions, in particular institutions engaged in teacher training, in every country. The initiation and implementation of inservice training programs for teachers who are unfamiliar with the contemporary concepts of mathematics is a prime community service.

THE PROBLEM AND ITS SIGNIFICANCE

The last few years have witnessed some programs of reforms in mathematics education in Nigeria. Both national and states' interests, including those of the Western State, have produced new curricula in mathematics for all levels of pre-university education. In describing its work, the mathematics group of

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[1]The National Council of Teachers of Mathematics, Administrative Responsibility for Improving Mathematics Program (Washington, D.C.: The National Council of Teachers of Mathematics, 1965), p. 11.

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[3]Ibid

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the National Education Research Council, Primary School Curriculum Workshop stated:[2]

> We are building a curriculum not only for the Nigeria of the 1970's but for a Nigeria of future decades changing and developing fast towards the 21st century.

However, the report of the group further indicated that:[3]

> There is an acute shortage of knowledgeable teachers. This is a problem which in the main must be resolved by every state and every Government, helped where necessary and possible, by the Federal Government.

Some attempts are being made to reform the teaching of mathematics in primary schools at the preservice teacher training level. Meanwhile, there is a whole generation of primary school teachers now in the schools whose basic education and training have neither prepared them to teach the content of the new curriculum nor use the methodology called for by the new reforms in mathematics teaching.

Yet, the effective teaching of mathematics at the primary school level is crucial to the attainment of educational goals and national aspirations. The Nigerian National Curriculum Conference of 1969 stated:[4]

> Primary school curriculum must aim at functional permanent literacy to ensure better producers and consumers of goods. It should provide a sound basis

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[2]Nigeria Educational Research Council, Report of Mathematics Group, National Workshop on Primary School Curriculum (Lagos: Federal Ministry of Education, 1971), p. 4.

[3]Ibid., p. 4.

[4]National Curriculum Conference in Nigeria, 1969. "Recommendations of the 1969 National Curriculum Conference." In: A.B. Fafunwa, History of Education in Nigeria, London: George Allen and Unwin, Ltd., 1974, p. 233.

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> for scientific and reflective thinking....It should develop in children mechanical, vocational and manipulative skills and competencies.

Furthermore, most educators predict that a very good grip on mathematical skills and concepts will be essential for coping with the complicated world in which children now in school will be obligated to live. There is evidence that many of the most important of these concepts take root most easily during the early childhood years. However, there is a contradiction between these facts and the mathematics instruction now given in the Western State primary schools. The problem lies mainly in the inadequate preparation that teachers have for mathematics teaching. Programs of inservice training and adequate guidance can be directed towards the correction of the defects in teachers' background knowledge.

PURPOSE OF THE STUDY

The purpose of this study was twofold:

1. to survey the existing state of mathematics inservice education for primary school teachers in Western State of Nigeria, in order to determine the degree of involvement of teachers in such programs, teachers' needs for the knowledge of the content and methods in the teaching of mathematics, and the views and preferences of teachers, headmasters and organizers on mathematics inservice training programs; and

2. to develop a model for a systematic inservice mathematics education program based on the survey findings and other research findings from a review of literature relevant to inservice training and the learning of mathematics.

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PROCEDURE AND SOURCE OF DATA

The procedure used in gathering data for this study included: (1) the review of literature on inservice mathematics education and other related theories, (2) the construction and administration of three sets of questionnaires, (3) the examination of governmental publications and documents, and (4) correspondence with governmental officials.

Literature Review

An extensive review of literature on inservice mathematics education in some countries was an essential tool of the study. Because of the changes in the elementary school mathematics program, inservice education for teachers has been recognized as a necessity by teachers, administrators and university personnel in many communities. Many patterns and practices of inservice programs have evolved. Information was gathered from literature on some of these patterns.

Other literary works used in the study were in the area of learning theories and mathematics instruction, theory and research on teacher education and on planned educational change. Governmental publications and documents were also used extensively.

The Survey Procedure

Many authors have recommended teacher-determined educational growth programs. Thelen[5] asserts that teachers are the

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[5] Herbert A. Thelen, "A Cultural Approach to Inservice Teacher Training," Improving Inservice Education: Proposals

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best judges of what should go on in programs of continuing education. Hawes[6] stressed that the curriculum planner must have certain basic information in order not to operate in a vacuum. This information, he added, should include conditions under which teachers work, their academic, linguistic and professional backgrounds, their attitudes towards the present curriculum and towards the proposal of change, their relations with the community they serve, their morale and future aspirations. The survey in this study was predicated on the above assertions. At the same time, the survey procedure put into consideration the level of academic sophistication of teachers involved in the study.

The major aim of the survey was to explore and describe teachers' participation in previous inservice training, their classroom practices related to arithmetic instruction, their needs for mathematical content and methods, and the views and preferences of teachers, headmasters and organizers[7] on inservice mathematics training. In selecting the sample of teachers and headmasters for the survey, many constraints made total randomization difficult. Among them were the cost of transportation to the primary schools, the uncertainty of postal system to all schools, and the non-availability of a

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and Procedures for Change. Rubin, L.J. (ed.) Boston: Allyn and Bacon, Inc., 1971, pp. 71-103.

[6]H.W.R. Hawes, Planning the Primary School Curriculum in Developing Countries. (Paris, Unesco: International Institute for Educational Planning, 1972), p. 25.

[7]See Appendix A, p.222, for individuals, associations and institutions designated as Organizers and/or Sponsors.

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comprehensive directory of the entire population of primary school teachers in the state.

The main sampling strategy, however, was to reach representatives of teachers in as many administrative divisions and geographical areas of the state as practicable within the given constraints. A two-stage cluster sampling was therefore designed. Schools were purposefully selected according to their location in urban or non-urban areas in the main administrative divisions of the state.[8] In each school, a stratified, simple random selection of Grade II and Grade III teachers was made. All headmasters of schools from which teachers were sampled were included in the survey.

The decision to limit the sample of teachers to a group of Grade II and Grade III teachers was based upon the fact that majority of the teachers trained for the state's primary schools are in this group. The 1971 Annual Digest of Educational Statistics of Western State, for example, showed that out of 16,292 total trained teachers, 16,035 (about 98%) were Grade II or Grade III. When examined on the total primary teaching force of 26,609 trained and untrained teachers, about 60% of the total group were Grade II or Grade III.[9] A second reason was that the basic mathematical training of this group of teachers can generally be identified. Their basic training only offered them a course in Arithmetic Process.

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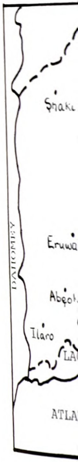
[8] See Map on page 8.

[9] Figures culled from Western State of Nigeria, Ministry of Economic Planning and Reconstruction, Statistics Division: Annual Digest of Education Statistics, (Ibadan: Government Printer, 1971), Vol, XI, p. 43.



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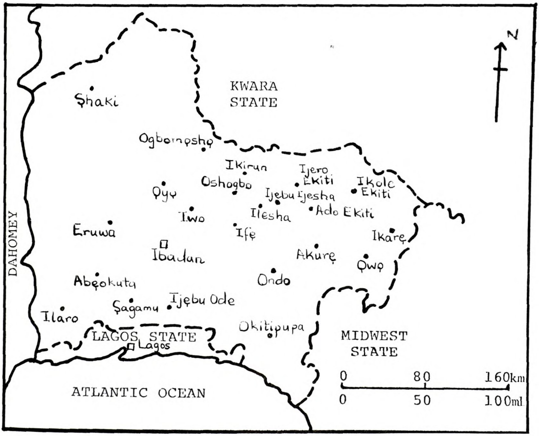

Figure 1. Western State, Nigeria: Divisional Headquarters

Source:- Ministry of Lands and Housing, Survey Division: Road Map of Western State, Nigeria, Second Edition, (Ibadan, Western State, 1969).

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Psychology

It was of interest to the study to investigate other forces inside and outside the schools which might influence the organization of inservice mathematics programs. Such conditions would give prerequisites for cooperation among bodies interested in inservice training and suggest the approach to the coordination of available resources. The headmasters' questionnaire was designed to collect pertinent information about the schools, general problems of and need for arithmetic teaching and their views on mathematics inservice training. Organizers and/or sponsors that were contacted are groups who had offered refresher courses on mathematics teaching in the state or those who have the potential for organizing or sponsoring such inservice programs.

Three sets of questionnaires[10] were designed for the survey: (1) the teachers', (2) the headmasters' and (3) the organizers' or sponsors'. Three different letters were written to three senior governmental officials to seek further information on governmental plans and policies on inservice training. In designing the teachers' questionnaire, attempts were made to control for acquiescent responses. Several studies conducted with African subjects have called attention to the importance of controlling for acquiescent response patterning in survey studies with less sophisticated respondents.[11] In

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[10] Questionnaires and Letters for Teachers, Headmasters and Organizers are found in Appendix B, pages 224 to 244.

[11] M.H. Segall, "Acquiescence and 'Identification with the Agressor' Among Acculturating Africans," The Journal of Social Psychology, 1963, 61:247-262.

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the present study, questionnaire items were stated in a way that they were not psychologically threatening to teachers. The introductory statement of each section presented the issue explored as a common problem for all teachers rather than a problem for a specific teacher. A balance was kept between open-ended and closed-ended questions as a means of capturing more of the complexities involved in the problem of study. This balance was also reflected in both the headmasters' and the organizers' questionnaires. Respondents were to remain anonymous, but they were given an option of indicating a mailing address if they were interested in a summary of the survey findings.

Although the pretesting of the questionnaires on a sample from the population of the research subjects was not possible due to the overseas distance involved, the teachers' questionnaire was pretested on a small group of West African students found in the Michigan State University community, who have had the experience of teaching in African primary schools. Some of these had taught as Grade II teachers until recently in Western State, Nigeria primary schools.

The questionnaires were reproduced at the Faculty of Education, University of Ife, Nigeria and later administered to teachers and headmasters in the selected schools by fifteen Associateship Diploma Course students of the Faculty, who were trained in the process of administering the questionnaire by a Faculty member. These students who acted as research assistants were formerly Grade II teachers in primary schools of

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Western State, and were familiar with the school community in which they administered questionnaires. Questionnaires were administered to a total of 80 headmasters and 400 teachers during the first term of the school year 1974-1975. Specifically, all school questionnaires were administered during the same week late in the month of November, 1974. The headmasters and teachers were found in 80 schools located in 18 urban and 12 rural towns[12], which are distributed throughout the 25 administrative divisions of the state. The Organizers' and/or Sponsors' questionnaires were also reproduced and mailed to respondents from Ife, while governmental officials' letters were sent directly from Michigan. The completed questionnaires were later mailed back to Michigan from Ife.

Since the questionnaire might have been a new experience for some of the teachers, research assistants answered questions on difficulty in understanding directions where they existed and saw to it that questionnaires were completed independently. Cognizant of the fact that the procedure of administering the questionnaire meant a break in the normal functioning of the classroom, a covering letter signed by the Dean of Faculty of Education at Ife accompanied the headmasters' questionnaires and solicited their cooperation. Headmasters and teachers were reported to have been very receptive and cooperative in particular because the average time for the completion of the questionnaire was approximately forty minutes.

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[12]See list of towns by urban and rural classificantion in Appendix C, Page 244 . Adopted from Ministry of Lands and Housing, Survey Division: Road Map of Western State, Nigeria. (Ibadan, Western State, 1969).

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Completed questionnaires were returned to Ife the same day by 380 teachers and 80 headmasters (95% and 100% responses respectively). The missing responses among the teachers occurred either because there were not as many teachers as desired in a particular school group or because some teachers who could have participated were absent from school on the day that questionnaires were administered. Of the organizers' questionnaires, two responses were received, one was a completed questionnaire and the other a note which explained that the organization had no immediate plan for inservice mathematics education. There was a response to one of the three letters written to the senior governmental officials. The response expressed the official's regret for his inability to make any statements on governmental policy as a civil servant.

Treatment of Survey Data

All aspects of data-coding were completed when responses were received back at Michigan. In order to describe the responses, statistical summaries were given on a number of single questionnaire items, most of which gave background information about teachers in form of frequency or percentage distribution. Subgroup analyses were examined to see if one subgroup of respondents was different from another. Because the sampling procedures were both purposive and random as described earlier, the use of standard parametric statistical techniques was limited. In most determinations, therefore, extensive use was made of means and standard deviations, percentage counts and the chi-square correlation method.

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In analyzing some responses, teachers were grouped by geographical location, class level, qualification and sex. Other subgroup explanations were given by categorizing teachers into subgroups of those who had previous attendance or no attendance at any inservice program and by subgroups of teachers' years of teaching experience. The descriptive variables examined included teachers' attitude towards arithmetic teaching and other mathematical activities. General classroom practices related to arithmetic teaching, including the materials of instruction and teachers' reference books were explored and described. The responses of teachers in Section III of the Primary Teachers' Questionnaire, dealing with mathematical content for inservice training were treated first on all teachers and secondly by an examination of teachers' views in subgroups of class levels taught.

Explanatory analysis of the headmasters' responses were given in three sections of the data analysis. The general information about the participating schools summarized by the use of percentage counts formed a section. The problems of arithmetic teaching in the schools as identified by the headmasters were analyzed in a second section. Other headmasters' responses were analyzed under the section on views and preferences on inservice programs. Information from the single completed organizers' questionnaire was summarized and discussed along with teachers' and headmasters' views and preferences on inservice mathematics programs.

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Developing the Model

The point of view adopted in designing an inservice model in the study is the one elaborated upon by Jackson as the "growth" approach to inservice training.[13] This point of view begins with the assumption that teaching is a complex and multifaceted activity about which there is more to know than can ever be known by any one person. From this position, the main motive for learning more about teaching and what to teach is not to repair a specific personal inadequacy in a teacher, but to seek greater fulfillment as a practitioner of the art. However, growth in a required cognitive learning is deliberately facilitated during such a total professional growth period. Jackson remarked that there were many routes to the central goals of inservice training based on a growth perspective. The choice of which route to take from among the many routes must be determined by the specific situation in which planners and the teachers find themselves. This professional growth should relate to life in the classroom. An implication of this growth point of view is that continuing education of the teacher should bear directly upon the problems he encounters in his work.

The basic strategies which underlie the design of a model in this study are, therefore, flexibility and adaptability. The following operational objectives are used as guidelines

[13] P.W. Jackson, "Old Dogs and New Tricks," Improving Inservice Education: Proposals and Procedures for Change, Rubin, L.J. (ed.), op. cit., p. 26.

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1. to examine and relate to the inservice model the social problems, values and beliefs gathered through the analyzed data and other known knowledge of the society.

2. to relate research findings on the nature of the learner and mathematics learning to the inservice programs.

3. to examine the new curricula in primary mathematics teaching in order to relate inservice learning experiences to these.

4. to relate theory and practice in teacher re-education and planned educational change across national boundaries to the inservice program design.

5. to develop from the previous four steps a rationale which will be used as a base for the proposed model. This model includes:

   a. establishing objectives
      i. criteria for the selection of objectives
      ii. a suggested list of objectives for inservice mathematics education in Western State.

   b. selecting learning experiences
      i. objectives of learning experiences
      ii. consideration of breadth and depth of mathematical content
      iii. mathematical topics for inservice programs
      iv. other learning experiences.

   c. organizing inservice programs
      i. components of organization
      ii. suggested methods for inservice programs

   d. a program of inservice evaluation

   e. summary of processes suggested for inservice mathematics training

6. to recommend an approach for inservice mathematics education to Western State, Ministry of Education, Institutions concerned with teacher education, and professional organizations in education and in mathematics education.

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BASIC ASSUMPTIONS

1. The teacher is a key factor in curriculum improvement.

2. The preservice training provided to the teacher is not adequate for the rest of his professional career for discharging his duties effectively.

3. The requirements of curriculum changes at the primary level from teachers with insufficient basic education may not be adequately met in a week's refresher course.

4. "A basic premise of inservice education is that professional growth of teachers will bring about increased achievement of learning in their pupils."[14]

5. "Most new and complex activities are more readily understood if presented in a model idealizing their essential components and operations."[15]

6. An extensive review of literature in curriculum improvement and research on inservice mathematics education in the United States and Great Britain may be helpful if translated to evoke curriculum improvement and research in mathematics education in Western State, Nigeria.

EXPLANATIONS OF TERMS

To convey connotations used throughout this study, a few terms are explained as follows:

1. Primary School Teachers: teachers who teach in institutions in which the program of instruction is from Grade 1 to Grade 6.

2. Grade II and Grade III Teachers: Grade II and Grade III are teachers' professional qualifications and not pupils' class levels. The Grade II teachers in the survey did not include pivotal teachers. Pivotal

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[14] W.R. Houston and M.V. DeVault, "Mathematics Inservice Education: Teacher Growth Increases Pupil Growth," Arithmetic Teacher, Vol. 10, No. 6, May, 1963, p. 243.

[15] H.J. Klausmeier and G.T. O'Hearn (ed.) Research and Development Toward the Improvement of Education. Madison, Wisconsin: Dembar Educational Research Services, Inc., 1968, p. 135.

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teachers are those who obtained the Grade II teachers certificate after a secondary school education. Chapter II gives further explanation on the educational background of Grade II and Grade III teachers.

3. Learning Experiences: the term "learning experience" as used in the study refers to the totality of experiences that help learning to occur. They include the content of the course, the activities performed by the learner and the facilitator, and his total interaction with the learning environment.

LIMITATIONS OF THE STUDY

Due to the fact that there are many categories of teachers in the state's primary schools, the population of teachers sampled is limited to Grade II and Grade III teachers. Nevertheless, the flexible nature of the model would allow for its modification for use with untrained primary teachers who are deficient in their mathematical background.

Because of the uncertainty of postal system, questionnaires were not posted, but administered in person by research assistants. There was no opportunity for a follow-up process.

A pretest of the questionnaire on a sample of individuals from the population of the research subjects was not possible due to the distance involved.

Costing of inservice programs is not undertaken though financial implications are raised.

Detailed learning experiences at different phases of the training program are not sought. They are to be determined by participants and the program leaders.

No empirical testing of the workability of the model was conducted in the present study.

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ORGANIZATION OF THE STUDY

Presented in this chapter were the problem of study and
s significance, the purpose of study, the procedure and
urces of data, the basic assumptions of study, explanations
terms, limitations of study and the organization of study.

Chapter II describes the setting in Western State,
geria. A brief historical synopsis of education in Nigeria
s given. Teacher education for primary schools and current
athematics programs both for primary schools and Teacher
raining Colleges are highlighted. New developments in
igerian primary education and their attendant consequences
or inservice mathematics education in Western State are
xamined.

Chapter III consists of a review of selected literature,
ealing briefly with learning theories and mathematics in-
truction, patterns and practices in inservice mathematics
raining, and theory and research on planned educational change.

Chapter IV presents an analysis of the survey data on
nservice mathematics education for primary school teachers.
esponses from teachers, headmasters and organizers respec-
ively are analyzed. Major findings of the survey are dis-
ussed and summarized.

In Chapter V, the model for inservice education is
eveloped. Taking into account the findings of Chapters III
nd IV and the setting described in Chapter II, criteria are
eveloped for the selection of inservice mathematics program

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objectives. This is followed by a description of the learning experiences, the organization of inservice training and a program of evaluation. Suggested mathematics topics and some evaluation instruments for inservice training program are developed. A summary of suggested processes is given.

Chapter VI concludes the study with specific recommendations for model implementation. Implications for inservice education of primary teachers and recommendations for further studies are given.

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CHAPTER II

WESTERN STATE, NIGERIA AND ITS EDUCATIONAL SYSTEM

The area now known as Western State of Nigeria[16] became an administrative unit in 1967 at the creation of Nigeria's twelve states. Prior to this date, it was part of the territory that became the British Colony and Protectorate of Nigeria in 1914. By 1939, it became one of the three regions of Nigeria, namely: Eastern Region, Northern Region and Western Region. As an administrative unit, Western Region of Nigeria included parts of Lagos Colony (now Lagos State) and the present Mid-Western State of Nigeria until 1963.

Western State, with its population of 8.92 million[17], occupies an area of about 75,369 square kilometers at the southwestern part of the country, which is mainly in the tropical forest area. The state is chiefly an agricultural community and one of the world's leading producers of cocoa.[18] Apart from providing food for the population, agriculture also supplies palm-oil and kernel, rubber, timber and kola nuts for export. Compared with agriculture, industry contributes only modestly to the state's economy. However, both factory

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[16] See map on page 21.

[17] Total Population by 1973 Provisional Census Figures. Reported in: West Africa, No. 2988, 23rd September, 1974, p. 1155.

[18] Encyclopedia Britanica, "Western State, Nigeria," Chicago: Encyclopedia Britanica, Inc., 1974, Vol. X, p. 627.

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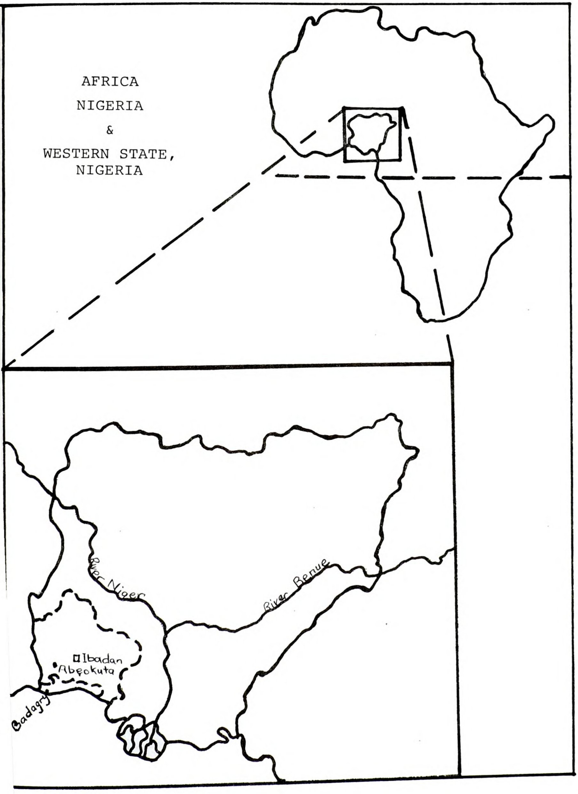

Figure 2. Location of Western State, Nigeria

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The state is primarily inhabited by the Yoruba people, group whose tradition of living in towns has given it a igh proportion of urban dwellers. Besides Ibadan, the state apital, there are at least a dozen other towns with popula- ions exceeding 100,000.[19] Nevertheless, village and rural wellings are still common. Ibadan and Ife are the two uni- ersity towns in the state.

HISTORICAL SYNOPSIS

he Beginning

Educational development in the Western State is closely ied to the development of education in Nigeria as a whole. ne existing system of formal education in Nigeria can trace ts origins to Christian Missionary enterprise during the ineteenth century. The starting point was in 1842 when a nall group of Wesleyan Methodists arrived at the costal town Badagry.[20] They established a mission station and opened school. The Wesleyan Methodists were followed in succes- on by the Church Missionary Society, the Baptists and final- the Roman Catholics. A number of primary schools were ened for the general education of the converts. Instruction

[19] Ibid., p. 627.

[20] The town, Badagry, was then in the Western Region. is now located in Lagos State.

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was given in the Four R's -- Reading, Writing, Arithmetic and Religion.[21] The purpose of the early education was to train teacher-cathechists, interpreters, servants and cooks. Education beyond the primary school was not an aim of the missionaries. For more than half a century, however, the missions were the sole operators in educational field. The British Administration contributed by establishing a Department of Education for Southern Nigeria in 1903.

The introduction of Western education into Northern Nigeria did not begin until more than half a century after the first mission school was opened in the South. This late development was due in part of the greater distance of the North to the coast. A more important reason was the fact that the area had been, and still is, a predominantly Moslem region with its own system of formal education. Adetoro added that the British Administration itself seemed equally unwilling to promote or aid the expansion of Western education in the Northern Protectorate.[22] In 1909, the British Administration established a Department of Education for Northern Nigeria and some government schools were opened in addition to the few existing mission schools in the north. Educational devlopment continued in both Northern and Southern Nigeria, however, it continued to be slow in the North.

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[21] A. Fajana. "Missionary Educational Policy in Nigeria: 1842-1882." West African Journal of Education, Vol. XIV, No. 2, June, 1970.

[22] J.E. Adetoro, The Handbook of Education in Nigeria, Ibadan: African Education Press, 1966, p. 22.

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The first teacher-training college was established by ıe Church Missionary Society in Abeokuta, Western State in 359. The institution was removed to Lagos following an out- reak against European missionaries and their expulsion from beokuta in 1867. It later began its third phase when it pened at Oyo in May, 1896 expressly to produce workers for ıe Yoruba mission. Lack of suitable candidates proved an bstacle to the expansion of the program, but by 1904, the rincipal reported that 29 teachers in all had been sent out nd were influencing at least 700 children. He also reported ıat students came from areas as far apart as east of the ver Niger, the Gold Coast (now Ghana) and the Hausa Mission Northern Nigeria.[23]

The need for trained teachers was already acute by the rst decade of this century, and in addition to the provision teacher training institutions in the western part of Nigeria, e missions in the east and the north also provided teacher aining programs. The curriculum of the early training in- tutes combined theology with teaching methods. At the end the two-year course, the teacher trainees took a prescribed chers' certificate examination and were certified if they sed the examination. In appraising the early elementary ool instruction in one of the areas, Inspector Cummings,

[23] T.T. Solaru. Teacher Training in Nigeria. Ibadan: an Univeristy Press, 1964. p. 5.

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porting in 1908, as cited by Solaru, revealed the need for acher training on a higher level:[24]

> The work of schools is fairly satisfactory up to Standard III. Beyond this stage when independence of thought is required, the results are not satisfactory -- not because the native child is incapable of thinking for himself, but the teachers are to blame to a great extent... Lessons are haphazard, no definite aim or system, and correct method is wanting. Too much talking to the child, hardly testing questions to train habits of correct thought.

The teacher trainees for the early training programs re drawn from Standard VI (about Grade VII). Before startg the two-year training course, they were expected to have rved as pupil-teachers for two years and to have passed the pil-teacher examination and then to have acted as assistant achers. The pupil-teachers were selected pupils, aged out fourteen, who had passed Standard V. They received one ur daily instruction from the head teacher or other approved acher, while they taught some classes during other hours. ring the two years of apprenticeship, grants were paid to head teacher who successfully prepared pupil-teachers for ir examinations. The pupil teachers received a token unt to supplement their allowance. The Phelps-Stokes Comsion Report of 1922 also criticized this system of teacherining as being unsatisfactory, partly because the pupilhers were overworked and underpaid and partly because the iculum was poorly conceived and the supervisory system

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[24] Ibid., p. 17.

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With the amalgamation of the two departments of education in the northern and southern provinces of Nigeria in 1929, the control of education became centralized. The new Director of Education then set himself to the task of the re-orientation and re-organization of the educational system along the line suggested by the Phelps-Stokes Report. Meanwhile, the gap in the educational development between the north and the south continued to widen. Through the years, other contributing factors such as the creation of free and universal primary education in both the western and eastern regions between 1955 and 1958, but not in the northern region; and the reticence of Moslem parents about the blessings of western education, especially for girls had intensified the problem of imbalance in the country's educational system. This imbalance has become one of the major educational challenges confronting Nigeria today.[25]

TEACHER EDUCATION AND PRIMARY SCHOOL INSTRUCTION IN WESTERN STATE

Teacher Training Programs

The training of competent teachers continues to be a most persistent educational problem beseting Western State. The 1929 re-orientation and re-organization of the education system referred to earlier led to the evolution of two types

[25] For more detailed descriptions of Educational Development in Nigeria see: Adetoro (1966), Fafunwa (1974), and Ukeje (1966).

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of teacher-training programs for elementary schools. These were the Elementary Training Centres (E.T.C.) for the lower primary school teachers and the Higher Elementary Training Colleges (H.E.T.C.) for teachers of the upper classes. The E.T.C. course lasted for two years and culminated in the Grade III Teachers' Certificate, while the H.E.T.C. course, also of two years duration, led to the Grade II Teachers' Certificate. A teacher trainee moved in succession through these courses. To go into the Grade III course, he must have been a pupil-teacher for at least two years. On the successful completion of the Grade III course, he had to teach for another two years before proceeding to the H.E.T.C. which offered the Grade II course. Some of the H.E.T.C. graduates taught at the E.T.C.'s.

These teacher training programs survived through the 1930's and most of the 1940's in this form. There were separate colleges for men and women, and the curricula were reviewed all through the 1950's. The curriculum of the E.T.C. was more practical and more suitable for the rural community, while that of the H.E.T.C. was more academically oriented. Among the prescribed subjects for both types of colleges were English, Arithmetic, Simple Accounts and School Methods. Both curricula reflected religious education since most of the voluntary educational bodies were missionary groups.

The war time economy of the 1940's affected teacher training programs in Western State. Salaries of experienced and

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trained teachers could no longer be met and some were replaced by untrained teachers for lower salaries. Shipments of books and equipment were lost. Many expatriate staff members left for good. Teacher training problems in general tended to receive less sustained attention than those of secondary education which had attracted the financial support of both the government and the voluntary agencies. As a result of this situation, staffing at both the teacher training colleges and the primary schools was unsatisfactory.

By the end of the 1940's, both government and voluntary agencies had produced proposals aiming at the improvement of the educational system. One of the proposals of the Church Missionary Society, for example, was to provide a one-year course for uncertificated teachers at three different centers in the state. This move may be regarded as one of the early concerted efforts towards the retraining of teachers with deficient background training other than through short refresher courses. Of great importance to later development in primary education in Western State was the Governmental Ordinance of 1948 which in addition to the provision of a framework for educational development for the following six years initiated regionalization of educational administration in Nigeria. The responsibility for education thus shifted from the missionaries to the regional governments. The Western Regional Government, like the other regional governments, assumed the responsibility for the provision of all educational facilities up to the pre-university level in its region.

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A major effect of the regionalization in the Western State was a great surge of energy for an interest in primary education that culminated in the establishment of universal primary education in the State which began in 1955.

To make the universal primary education program a reality, a large number of new teachers had to be supplied for the projected increases in the number of schools and in pupil enrollment. The introduction of such a vast scheme of primary education posed immediately the problem of the training and supply of large numbers of teachers. To meet this exigency, local authorities and voluntary agencies established several Grade III colleges with financial support from the regional government. As a result of the scheme, a large number of children have received primary education, but a large number of untrained or half-trained teachers were left in the school system by the scheme and thereby lowered the standard of education.

In 1959, of a total teaching strength in primary schools of 37,544 persons, there were 23,979 or 64% uncertificated and without training, while 920 or 2% were on probation.[26]

At this point, one year before Nigeria's independence, the federal government set up a nine-man commission, chaired by Sir Eric Ashby, to recommend a pattern of education which would match Nigeria's aspirations over the first twenty years of independence. Teacher training for primary schools formed

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[26]T.T. Solaru, op, cit., p. 102.

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a significant part of the commission's report, although the commissioners were primarily concerned with post-secondary and higher education. Ashby Commission stated in its report submitted in 1960:[27]

> Education is a seamless web; although the primary and secondary schools lie outside our terms of reference we cannot disregard the fact that some 80,000 teachers are seriously deficient in general education, especially in spoken and written English. Accordingly, our recommendations include not only proposals for increasing the numbers of teachers, but also proposals for improving the quality of teachers already in Nigerian schools. The problems which face the country over teacher-training are very formidable indeed.

Still more specific to the present study is the report of the Banjo Commission appointed to review the educational system of Western Nigeria in December, 1960 as a result of the earlier nationwide review. As it was the case in the Ashby Commission Report, teacher training was also at the heart of this review. "Evidence shows that all types of educational institutions in the region lack adequate, stable and qualified academic staff. To remedy this alarming situation, the most urgent measures must be taken."[28] The Commission made many recommendations and suggestions of significance to the improvement of primary education. In particular,

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[27] Federal Ministry of Education, Nigeria. Investment in Education. Report of the Commission on Post-School Certificate and Higher Education in Nigeria (Lagos: Federal Ministry of Education, 1960), (Ashby Commission Report), p. 15.

[28] Western Nigeria Government. Report of the Commission Appointed to Review the Educational System of Western Nigeria (Ibadan: Government Printer, 1961), (Banjo Commission), p. 49.

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it emphasized that:[29]

> All these things, however, would be valueless without an attack upon the greatest of all weaknesses in the schools of the Region, namely, the use of ill-educated and unqualified people as teachers. Primary schools in which two-thirds of the teachers are unqualified and in which many have nothing more in the way of education than their own years as primary school pupils, are scarcely worthy to be called schools at all.

To remedy this situation, the Commission's recommendations included the complete replacement of untrained teachers by trained personnel, the introduction of a system of promotion for conscientious teachers, the improvement and reorganization of the system of supervision.

No doubt the rapid expansion of the mid 1950's which was not preceded nor accompanied by a corresponding increase in appropriate teacher-training programs contributed to lower an already low standard of education. Some of the Banjo Commission's recommendations resulted in the initiation of some teacher training improvement programs, while others, in particular the recommendation on the replacement of untrained teachers accordingly received many criticisms for being unrealistic. In the first instance, the trained teachers were not available and it would have been unethical to dismiss the untrained teachers who served the society when they were needed. The recommendations of the Ashby Commission also led to the establishment of some refresher courses aimed at improving the

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[29] *Ibid.*, p. 11.

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As a result of the Banjo Commission's recommendation, :he Grade III teachers' course was abolished in the early .960's and a two-year residential training program to up-rade this group of teachers to Grade II has been mounted ince then. Though the Grade III teacher training programs ave been terminated, the products of these early programs till linger on in the teaching force and their poor quality s still well reflected in the primary classrooms of Western tate. The 1971 Annual Digest of Education Statistics, for xample, showed that out of a teaching force of 27,016 in its rimary schools, 34 percent were Grade II, 15 percent were rade III, 38 percent were untrained, 10 percent were trained ut uncertificated,[30] 15 percent were special vernacular or andicraft teachers, and one percent had qualification that as better than Grade II status.[31] The Grade II Teachers' ertificate is the official minimum qualification for the rimary teacher in Nigeria. In effect, a total of about 63 ercent of all the teachers have inadequate qualifications r primary school teaching. These 1971 figures seemed to flect only a slight difference from the 1959 figures men-oned earlier. The adequacy of the Grade II teachers course becoming more and more questionable especially when one

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[30]An uncertificated teacher went through the program of aining but failed the Teachers' Certificate Examination.

[31]Calculated from: Annual Digest of Education Statis-cs, op. cit., p. 43.

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nary School Instruction

The statistics on the categories of primary teachers ed in the last section has great bearing on the type of rning environment that exists in the Western State primary ssrooms. Evidence abounds in writing, speeches and dis- sions that point to the dissatisfaction which many people he state have with the present primary education system. rly thirteen years after the introduction of the six-year primary education in the region, the Taiwo Commission set up to review the educational system. In unequivocal s, the Taiwo Commission put the cause of the high wastage and the serious deterioration in primary education stan- in the poor quality of teachers. The Commission's re- states:[32]

> We are in no doubt that two major reasons why the educational objectives implicit in the primary school curriculum in the west are imperfectly real- ised are deficient knowledge of subject matter on the part of too many teachers and an inadequate conception of the teaching function....We were not a little disappointed to find how little primary education has been touched by findings on psychology of learning, the mental development of children, the teaching of languages, the formation of skills, team teaching, etc.

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[32] Western State of Nigeria: Report of the Committee on ?eview of Primary Education System in the Western State .geria (Taiwo Commission Report), Ibadan: Government .er, 1968, p. 11.

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A closer look at the instructional program shows specific
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ram places emphasis on English language, Yoruba language
Arithmetic. Other subjects taught include religion, hand-
ing, history, geography, nature study, health and physical
ning. Social studies, as a substitute for history and
raphy, science and mathematics are now taught in a few
ols. English is the medium of instruction in the upper
s. The first two or three years are usually taught in
a language. The First School Leaving Certificate, a
al examination given by the state, marks the end of the
ear course.

Much of the teaching is done with an eye on the syllabus
he First School Leaving Certificate Examination. The
al learning environment is very formal. The relationship
en the teacher and the child can be indicated by the word
oritarian." The teacher demands a formal and automatic
t from the child. The children are hemmed in by admoni-
They are passive and not active learners. They are
allenged to reason reflectively, to observe and to dis-
When Calcott[33] investigated the causes of wastage in
y education in one of the provinces in 1967, he found,
other causes, that "Some children do not like the severe
line which is often administered by teachers -- particu-

[3]D. Calcott. "Some Trends and Problems of Education
tern Nigeria, 1955-1966." West Africa Journal of
on, Vol. XI, No. 3, Oct., 1967, pp. 128-135.

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arly to new enrollments -- in order to get the children to conform'. These children then beg their parents to let hem stay at home."

Furthermore, most instruction is characterized by routine aching and rote learning. The common teaching aids are the ackboard and chalk, the latter being in short supply in some hools. Materials of instruction, including textbooks for pils and resources for teachers, are inadequate. Some teachs attempt to improvise teaching aids. Unfortunately, some dels improvised by teachers are distorted to such an extent at pupils are led to incorrect concepts. In general terms, e poor quality of teaching in these primary classrooms had en succinctly expressed in the 1967 report of a study by e Education and World Affairs Committee on Education:[34]

> There is a gross efficiency in the primary educational system. Sixty-three percent of those pupils who entered the primary cycle which terminated in 1965 did not complete that cycle. The quality of instruction at the primary level is notoriously poor.

CURRENT MATHEMATICS PROGRAMS: PRIMARY SCHOOLS AND TEACHER TRAINING COLLEGES

An examination of the school mathematics programs shows acute instructional problem. Mathematics is universally nowledged in the Western State as being a very important ject, and yet it is a subject that many pupils dislike

[34]Education and World Affairs, Nigeria Human Resources elopment and Utilization, New York: EWA Committee on cation/USAID, 1967, p. 130.

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ıd fear. The results in external examinations are generally ɔor, and very few students pursue the subjects through to egree level. Indeed, given the whole population of the state, ıly 83 graduate mathematics teachers were reported as teach- g in the secondary schools in 1970.[35] Of these, a substan- al number did not hold a degree in mathematics. Many hold grees in agriculture or economics, but since they studied thematics up to Higher School Certificate level and since e schools lack any teacher of mathematics or have too few ch teachers, the graduates in these other disciplines are ed as substitutes. The situation is particularly acute in e Teacher Training Colleges where only a few teachers are iversity graduates.

mary School Mathematics Program

With insignificantly few exceptions, many of the state's mary schools are still teaching from the same or similar hematics curriculum which they taught from two decades ago. eed, it is doubtful if mathematics, as opposed to arith- ic, yet exists at all in the vast majority of the state's mary schools.

The present arithmetic syllabus[36] shows two striking

[35] A. Adaralegbe. "Western State," Report of the Supply Secondary Level Teachers in English-Speaking Africa, Secon- Level Teachers: Supply and Demand in Nigeria, Hanson, (Project Director), East Lansing: Institute for Inter- onal Studies in Education and African Studies Center, , pp. 36-54.

[36] Western Nigeria Ministry of Education, Primary School abus (Ibadan: Government Printer, 1954), pp. 36-48.

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ficiencies: narrowness of scope and lack of a clear state-
nt of objectives. Arithmetic is mathematics, but it is a
oset of the body of knowledge known as mathematics. There-
re, the narrowness of the arithmetic program is a matter of
ncern if the state's primary school mathematics program is
offer a solid foundation for the type of mathematics edu-
ion which is essential for a society aiming at scientific
technological development. The second defect is a matter
pedagogy. The role of clear instructional objectives is
amount in any learning-teaching situation. It is par-
ularly needed when teachers are inadequately prepared for
ir jobs. An enriched mathematics program, including some
ic concepts of algebra and geometry, will not only make
a better understanding of geometric patterns and objects
are present in the child's everyday experience, but also
long way to provide the hitherto missing link between
primary and secondary school mathematics programs. Fur-
nore, such an enriched program would provide a more
tional mathematics education to those children for whom
ary education is terminal.

It is in arithmetic, more than any other subject, that
ing is a little more than rote memorization. In this
am, mathematics is taught in a purely mechanical way.
s are memorized and operations are carried out accor-
to rules which are seldom explained. Children embark,
from the start, on learning the two times table up to

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x 12 and then proceed to the three times table and so on. e relationship between 2 and 4, 5 and 10, and among 12, 2, 4 and 6 are seldom pointed out or made use of. Sums are ually mechanical and it is usual for all the four fundamen-l operations to be learned and practiced mechanically before y of them is used for any practical purpose. When they are arned, they are applied, equally mechanically, to length, ea, volume and money. Until recently, the Nigerian money stem made the process laborious, but the recent adoption of decimal system should eliminate this difficulty if teachers ke the necessary transition.

Finally, after the long course of mechanical learning and rking, the "Problems" are introduced. Most of these pro-ems are still mechanical sums wrapped up in words rather an being practical problems. They are often concerned with real and irrelevant situations such as finding the cost of per needed to cover the walls of a room, a situation that totally absent in the child's environment. In general, me of the children learn these mechanical processes with eat success and produce exercise books of neatly and cor-ctly worked sums without ever acquiring much understanding mathematics or seeing the link between the subject and demand for correct change in the market place. A few pro-ts of the system have progressed beyond the primary school learned some real mathematics. However, a good many seem have developed a mathematical phobia which may last for the rest of

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the rest of their lives. It must be said that although a few teachers have done some good work of arithmetic teaching, yet the description of the learning climate above generally holds. Professor Ukeje's comment on this learning climate almost ten years ago seems to hold presently. He wrote:[37]

> The schools impart knowledge with little reflection; they teach the students what to think but not how to think; they tell them what to know but not how to know, and the students acquire knowledge with little understanding; they learn to memorize but not to digest, to repeat but not to reflect, and to adopt rather than to adapt.

The Teacher Training Mathematics Program

The mathematics programs of the Teacher Training Colleges suffer similar deficiencies as that of the primary schools. The syllabus is an "Arithmetic Process" program and appeared to have been designed to give the teacher just enough arithmetic to "give" to his pupils. A new "Basic Mathematics" syllabus has been recently introduced in the Teacher Training Colleges. This new syllabus is wide in scope and contains a considerable amount of the new materials called for by the contemporary reforms in mathematics. There is evidence of the need for a continual revision and adaption of the new syllabus.

The new syllabus, published by the West African Examination Council,[38] is an optional alternative to the "Arithmetic

[37] Ukeje, B.O. Education for Social Reconstruction, Lagos: Macmillan and Company (Nigeria) Ltd., 1966, p. 79.

[38] West African Examination Council conducts central examinations on behalf of the Federal and States' Governments of Nigeria and some other West African countries.

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ocess" in the annual Grade II Teachers' Examination as from 71.[39] It is planned that the new syllabus will become a npulsory program for all Teacher Training Colleges in the ntry probably from 1976. However, less than five of the Grade II Teachers' Colleges in the Western State sent in didates for examination in the new mathematics syllabus June, 1973.[40] One or two other colleges planned to intro- e the Basic Mathematics syllabus in September, 1973, while t of the others had no definite plan at that time as to n they would offer courses to teacher-trainees in mathe- ics as opposed to the arithmetic course. An implication this situation is that for some years to come the new chers trained in these colleges will most probably still deficient in their mathematical background.

There are also grave pedagogical limitations in the pro- n at the teachers' colleges. The trainee is taught arith- c as a series of facts to be learned independently. For- s are learned with or without deriving them and rules are ied without understanding why they work. The demonstra- of one or two algorithms on the blackboard followed by completion of similar examples by the trainees is a usual ccupation. The main approach is through "talk and chalk".

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[39] West African Examination Council, Teachers' Higher entary (Grade II) Certificate Examination: Regulations Syllabuses (Lagos: Nigernews Publishing Company, Ltd.,), pp. 20-35, 18-19, 47-55.

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However, even with the type of new program described, little will be gained unless the teacher training procedures used are also modified.

Evolving Programs for the Primary Schools

Although the present school mathematics program in the Western State is still very traditional in nature, some attempts have been made during the last decade aimed at reforming the mathematics curriculum. Significant among these is the African Mathematics Program of the Education Development Center, an American-based research foundation.

The program was inaugurated in Accra, Ghana, in 1961 with a policy of bringing together Africans, Americans and British Educators in English-speaking African countries in order to influence mathematics education in Africa.[41] To achieve its objectives, it organized writing workshops in Africa which produced the Entebbe Mathematics series. Between 1962 and 1969, the African Mathematics Program conducted annual eight-week writing workshops in Entebbe and Mobasa for resource persons and produced over 80 volumes of textual materials. Among these are experimental textbooks for primary schools and teacher training colleges. Although the primary objective of the workshops was to produce good mathematics texts, it was hoped that participants at the writing workshops

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[41] B.O. Ukeje. "The Entebbe Mathematics," West African Journal of Education, Vol. 9, No. 1, February, 1965, pp. 15-18.

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ould develop interest in writing and use their experience
 assist in national curriculum change.

The program, however, left its impact on Western State
 the form of the produced texts for schools and some ad hoc
service training programs which were carried out through
e Institutes of Education in Ibadan and Ife. Most of the
achers in these inservice programs were secondary school
d teacher training college teachers and only a few were
imary teachers. A 1970 report of the foundation stated,
ll of the participating countries have accepted the idea
at 'modern mathematics' must be introduced into their
hool curricula, although just how this should be done may
 be clear."[42] This is true of the Western State as it is
 some of the other countries.

Cognizant of the need for a curriculum reform at the
mary level, the Western State government, by 1972, had set
a series of syllabus committees to review the existing syl-
uses of the primary school and suggest a new curriculum.
 mathematics curriculum panel had completed work on a new
hematics syllabus proposed for the primary school. However,
Hawes asserted, curriculum change depends on people, not
paper.[43] New approaches to mathematics, involving the
ning of new concepts and an entirely new approach to num-
relationships will have to be learned or relearned by many

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[42] Education Development Center. African Mathematics
ram: A Report (Newton, Mass., June, 1970), p. 3.

[43] H.W.R. Hawes, op, cit., p. 21.

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teachers. Even in situations where teachers' general education is regarded as being adequate, such a new mathematics program necessitates that teachers' knowledge of mathematics be brought up to date. In a situation where teacher's general education and professional training are inadequate, as it is in the Western State, the need to train teachers in the content of mathematics and teaching methods becomes greater, if quality mathematics teaching is desired. The problems of training and retraining of teachers and other factors affecting quality of instruction are highlighted in the next section.

PROBLEMS OF IMPROVING INSTRUCTIONAL QUALITY

With few exceptions, the problems of mathematics instruction at the primary school level are also problems of general instructional quality. Among these fundamental problems are: (1) teacher preparation and conditions of service, (2) materials of instruction and (3) supervision and retraining of teachers.

Teacher Preparation

One reason for the large number of untrained teachers in the primary schools was the lack of an adequate number of qualified personnel to meet the demands of universal primary education in the 1950's. Through the years, some progress was made as Taiwo Commission reported a good 83 percent trained teachers were in the primary schools in 1966.[44] It

[44]Taiwo Commission Report. op. cit., p. 8.

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must be recognized, however, that the fact that a teacher was deemed trained does not guarantee an individual with a broad academic background. In addition, many of the "trained teachers" of 1966 were Grade III teachers, while some others were uncertificated Grade II or Grade III teachers. A trained but uncertificated teacher is one who, although completed a course of training at a teachers' college, failed to obtain a certificate because of unsatisfactory performance on the leaving examination. Thus, the actual progress made in the quality of trained teachers in the mid 1960's was in fact minimal. It was, therefore, not surprising that in a 1973 "Project Know Your Teachers" the state reported that 52 percent of primary school teachers were untrained.[45] It seems clear that there are some embedded problems in the teacher preparation process which should be reorganized.

Just as the quality of teaching is impaired at the primary level because of poor quality of the teachers, so does the lack of qualified teachers create problems at the training colleges. The courses offered in the training colleges do not reflect the changes in the syllabus which involve the use of new teaching approaches. "The sweeping changes and concepts in modern language learning, the new mathematics, programmed learning and elementary science all of which involve the use of Audio-Visual materials, are unknown in our

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[45] Editorial Comment. "Sending Nigeria to School," West Africa, No. 2962, March 25, 1974.

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training institutions," wrote a Nigerian teacher.[46] The training colleges themselves need a corps of properly trained teachers.

In addition to the problem of the teacher trainer, other problems plaguing teacher preparation for primary schools are those of poor recruits, poor training programs, high failure rate[47] and poor rewards. The problem of reward, coupled with some other complex causes in the society have contributed to the general low morale of the teachers, which in turn affects the quality of teaching in the classroom.

Materials of Instruction

The physical surrounding for learning is as important as the social climate provided by the teacher and a child's peer. Children need a stimulating environment, designed to pique curiosity, to entice and to challenge. Several materials of instruction including textbooks and various teaching aids are needed for such supportive physical environment. The acute shortage of these teaching aids in many primary schools of the state is a great constraint on instructional quality. This shortage is a handicap for mathematics teaching, where a great many concrete aids are needed in simplifying abstract ideas.

[46] S.O. Olukoya, "The Functions of Audio-Visual Aids in Teacher Training Colleges," Teachers' Forum, (Ibadan: Government Printer, 1974), Vol. 2, p. 5.

[47] Teachers' Certificate Examination Grade II, June, 1973. Results showed: 53.6% pass, 35.3% referred, 11.1% failed. Calculated from Teacher Forum, Ibid., p. 12.

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Attempts are being made to improve the present curriculum for the primary schools. However, the issue of the central and external examination at the primary level will have to be resolved in order to remove a formidable obstacle to instructional quality. An examination does not have to foster rote-learning, as some writers maintained.[48] To serve its purpose, examinations should be used to check if the objectives of instruction have been achieved, not to check memorization. Any design of a new primary education must also plan for a new way of assessing the program.

Supervision and Retraining

Many authors have written copiously on the shortage of qualified supportive administrative personnel for the primary schools. The report of Taiwo Commission in 1968 stated that:[49]

> The Inspectorate for reasons not of its own choosing is ill-equipped to provide the kind of leadership which an efficient and dynamic educational system demands. In this connection, the most glaring omission is the lack of a senior officer whose full-time preoccupation is primary education.

The Commission added, "We strongly urge that the position should be remedied." In order to aid quality of instruction at the primary level, the school inspector must be able to assist classroom teachers, in particular the unqualified ones,

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[48] UNESCO/UNICEF. The Development of Science and Mathematics Concepts in Young Children in African Countries. Nairobi: UNESCO/UNICEF, 1974, p. 70.

[49] Taiwo Commission Report. op. cit., p. 21.

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while he is at work in the schools. He should be able to assist in the development and introduction of new teaching techniques and related teaching aids. Unfortunately, the cadre of school inspectors that can effectively perform such roles are still being developed.

The need for retraining of teachers has been emphasized all along, though the lack of it continues to be one of the obstacles for instructional quality. As far back as 1959, J.O.A. Herrington, then of the Education Serivce of Western Nigeria, remarked:[50]

> Refresher courses are not new things, but we feel that many of the refresher courses that have been held in the region are not particularly valuable. They are too diffuse, and they try to do too much in a short time. We want to overhaul the system.

The Ashby Commission in 1960 also recommended vigorous efforts to raise the quality of work in the schools, in particular in the primary schools. This recommendation led to the beginning of an annual refresher course for teachers. The Ashby Courses, now known as Teachers' Vacation Courses, aimed and still aim, at giving participants short refresher courses in both special and general methods of teaching in subjects such as English, Arithmetic and Science. These refresher courses have reached only a few teachers and do not cover many mathematical topics. Although modest attempts are still being

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[50] J.O.A. Herrington, "Problems of the Inspectorate in Western Nigeria," Overseas Education, Vol. XXX, No. 4, January, 1959, p. 179.

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de to reorientate teachers, the task of upgrading the know-dge of teachers who have insufficient education is still itically needed. After a lengthy appraisal of the teaching tuation, the Lagos Curriculum Conference made this recom-ndation:[51]

> Inservice training and retraining of teachers at all levels must be embarked upon on a continuous basis with a mind to improve teacher/classroom effectiveness and to encourage him through further incentives for additional experience gained. Prospects for further training should be built into the teacher-education programme and this should be adequately compensated for or remunerated as an additional incentive.

ecial Needs of Mathematics

While much of the above is common to all subjects, there e certain features which make mathematics a peculiarly sen-ive subject and this nature of the subject should be under-od and appreciated by all teachers teaching the subject. st, social and cultural experiences, including language, relevant to the reform of mathematics teaching. Spatial dynamical experiences, for example, are different from up to group. Yet, these experiences contribute tremendous- to mathematics learning that some form of each experience ds to be provided for in order to enhance learning in some uations. Secondly, mathematics has developed rapidly with-he last ten years that most teachers need to upgrade their ledge of it. Thirdly, contemporary research has shown

[51] A.B. Fafunwa (1974), op. cit., p. 238.

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:hat children are ready to learn mathematical concepts at :ertain stages of development. This is an important area of ıathematics learning-teaching which all teachers must under- ;tand. Lastly, there is the need to use and consider the :ffectiveness of simple teaching materials and apparatus in .eaching mathematics and teachers need to be trained in the .se of some of these.

These special needs of mathematics make the retraining f teachers for mathematics teaching more significant, espe- ially teachers with deficient mathematical background. The roblem of mathematics instruction in the state tends to be elf-perpetuating. A shortage of good qualified teachers esults in poor teaching, which in turn results in the alien- tion of the next generation of school children from the sub- ect. Yet, no major impact may be made on the whole standard mathematical education without involving the primary schools. is, therefore, necessary to effect change in the present imary school mathematics through both viable preservice d viable inservice courses for primary teachers.

PROMISING DEVELOPMENT

Since the possibility of any fundamental improvement in ucation and training of teachers (like any marked improve- nt in any segment of the plant, plan and personnel of edu- ional system) is closely interrelated with large scale ends in all sectors of a nation, recent development in eria holds some promise for primary educational development and impro

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and improvement. In its attempt to rectify the different imbalances in education, the Nigerian Federal Government has committed itself to nation-wide universal primary education scheduled to begin in September, 1976. The plan for expansion has resulted in another appraisal of the existing primary education system in every state of the country. Bearing in mind the lesson from the past period of expansion in some parts of the country, the government is making plans for qualitative improvement amidst quantitative expansion in order not to further lower an already inadequate level of primary education.

Among the measures being taken in this direction are plans to upgrade the academic and professional standards of primary school teachers and to improve their conditions of service. The financial remuneration of primary teachers has been increased beginning with the current fiscal year to about three times the old salary after the recommendation of the Udoji Commission.[52] These new developments are necessary if quality instruction is to be provided in the primary schools. In the words of Professor Beeby, "Reformers' efforts will be largely wasted if salaries and conditions of service of the primary teachers are not such as to retain good people in the profession."[53]

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[52]Federal Republic of Nigeria: The Public Service of Nigeria. Government Views on the Report of the Public Service Review Commission (Udoji Commission), December, 1974, p. 20.

[53]C.E. Beeby, The Quality of Education in Developing Countries. Cambridge, Mass: Harvard University Press, 1966, p. 130.

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It is, however, necessary but not sufficient to raise the standard of intake into preservice programs in teacher training colleges in order to maintain quality in the school system. A systematic retraining and retention of those teachers already in service is also essential to quality instruction. The new developments are needed to raise the norale of practicing teachers and provide both financial and emotional incentives which are conducive for their partici-pation in inservice training programs. These systematic re-training programs could be organized in different stages or hases with emphasis on a particular subject matter or a articular teaching-learning skill at a given stage.

Another development of significance that holds promise or teacher retraining is the growing communication among ducational bodies both in and outside the Western State. ne State University at Ife houses an Institute of Education, hich is governed mainly by three educational bodies, namely: ne university, the Western State Ministry of Education and ne Teacher Training Colleges. This group could provide a rum for coordinated effort and plans aimed at the re-educa-on of primary school teachers. Similarly, Western State ucational bodies are participants in an international co-erative effort of the Association for Teacher-Education in rica.[54] Among the objectives of the organization are:[55]

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[54]Association for Teacher-Education in Africa is an off-ring of The Afro-Anglo-American Teacher Education Programme .A.A.), an association established in 1960 and financed by

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1. to strengthen the teacher-education programme in Africa through regular annual conferences of directors of institutes and others interested in African teacher-education programmes, for example, the Ministries of Education, teachers colleges in Africa, the United Kingdom and the United States;

2. to conduct research and promote the exchange of information among the participating members from the three continents.

The activities of such an organization, especially the promotion and exchange of ideas on teacher education programs could further indicate the needed professional cooperation among educators and educational planners in periods of rapid educational changes.

SUMMARY

In this chapter, the setting for in-service mathematics education has been described. Since the professional training of teachers is closely connected with what is happening in schools and what is planned for schools, the description of the Western State setting covered: (1) the development of primary education, (2) the development of teacher training programs and their inadequacy, and (3) the problems of instructional quality.

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the Carnegie Corporation of New York. Educational bodies represented in the association include: Teachers College, Columbia, the University of London Institute of Education, Ministries and Institutes of Education and Teacher Training Colleges in some thirteen African countries.

[55] A.B. Fafunwa, (1974), op. cit., p. 202.

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Specifically, mathematics programs and instructional problems in mathematics were highlighted. Finally, the current social and economic events in the society that are conducive to primary teacher retraining programs were mentioned.

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CHAPTER III

THEORETICAL BACKGROUND AND RELATED RESEARCH

There are three main areas of theory and research related to the problem of inservice mathematics education for primary school teachers. First, this study fits into the area of mathematics learning since the subject matter for retraining is mathematics. Secondly, the study deals with the issue of helping to shape teachers' understandings of mathematical concepts, their attitudes towards and their techniques of mathematics teaching. Therefore, the study fits into the general framework of inservice education of teachers. Finally, in order for teachers to demonstrate these competencies, they may need to change not only their own behavior, but also the organization and management of their classrooms, their mode of interaction with the learner, and perhaps the system of social norms in the school as well.

This chapter will discuss the related theory and research from each of these three areas, including any significant work from the setting of study.

SOME LEARNING THEORIES AND ELEMENTARY SCHOOL MATHEMATICS INSTRUCTION

Extensive research into the various aspects of elementary school mathematics has been reported not only in published

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published and unpublished research but also in journals, monographs, periodicals, professional books, and publications of government and learned societies. Several authors on both sides of the Atlantic have, at various times, presented views on learning theories for the study of mathematics learning, teaching and understanding.[56] "The days when a teacher of mathematics could shut his eyes to psychology, and dismiss it as well-meaning advice of which he had no need, or as opinion which he did not share, are gone," observed Fletcher.[57] Theories of learning have influenced curriculum and instruction in mathematics. However, no single theory of learning has proved robust enough to encompass the range of complexities involved in mathematics instruction. Consequently, a teacher of mathematics must borrow selectively from a variety of psychological theories those principles most relevant to the particular instructional decision he has to make.

In "Psychology and Mathematics Education"[58] and in "Psychological Controversies in the Teaching of Science and

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[56] For further information see bibliographical entries under the names of: (1) McConnell, T.R., (2) Brown, K.E., (3) Buswell, Guy T., (4) Wallace, J.C., (5) Weaver, J.F., or (6) Crosswhite, F.J., et al.

[57] T.J. Fletcher, Some Lessons in Mathematics, Cambridge University Press, 1964, p. 2.

[58] Lee S. Shulman, Psychology and Mathematics Education, In: E.G. Begle (ed.), Mathematics Education, 69th Yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press, 1970, pp. 23-71.

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Mathematics,"[59] Shulman has presented and analyzed what represents the current Western thinking on the psychology of mathematics education. The literature review at this point centers around some theories and studies on cognitive aspects of mathematics learning and instructional process, especially on the issue of their applicability in non-Western culture.

Studies in Cognitive Development and Mathematics Learning

> "We begin with the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development....The task of teaching a subject to a child at any particular age is one of representing the structure of that subject in terms of the child's way of viewing things."
>
> Bruner, 1963, p. 33.

Although the universality of the subject matter of mathematics is generally accepted, the universality of the theories of mathematics education calls for a re-examination in an era when transplantation of ideas and theories in education is constantly being questioned. The great bulk of the research on the development of cognitive skills and the derived theories have been carried out with Western children. Similarly most of the mathematics curriculum building based on the theories of Piaget, Bruner, Gagne, Ausubel and others has gone on in Western educational systems. Sometimes such curricula

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[59] Lee S. Shulman, "Psychological Controversies in the Teaching of Science and Mathematics," The Science Teacher (September, 1968): pp. 34-38.

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have been transferred, almost unaltered, to non-Western societies; in other cases, they have been adapted to meet local needs. However, very seldom, if ever, has their fundamental, psychological, logical basis been questioned. Is it the case that the theories of cognitive development on which they rest stand up in non-Western contexts? Do the primary school children in Western State, Nigeria, for example, develop cognitive concepts in the same way as the American children? If not, what are their modes of concept formation and what are the implications for mathematics curriculum and for the teaching of mathematics?

Much progress has been made in this century in understanding the learning of mathematics. The educational and psychological research into the growth of pupils' thinking, much of it carried out and inspired by the Geneva School under the direction of Piaget, Inhelder and their co-workers, have had great influence on the current thinking about mathematical learning of children.

The work of Piaget not only embraces studies of children's general intellectual and logical development, but also the more specific studies of the growth of number and mathematical concepts. There have been several major publications on the method, results and underlying thinking in this field. Of particular interest to the teaching of mathematics among them are Piaget (1952a), Piaget and Inhelder (1956), Inhelder and Piaget (1958), Piaget, Inhelder and Szminska (1960), Piaget and Inhelder (1964), and more recently, Copeland (1974).

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In The Origin of Intelligence, Piaget subscribes to the importance of heredity in intellectual development. However, he asserts that such inherited structures alone cannot explain development. Other factors of development are found in the interaction of the endowment and experience in the environment. Intellectual development proceeds through major stages which are continuous and fixed in order. These stages are called sensorimotor, preoperational, concrete-operational and formal operational. All persons develop through the stages in the same way, though not necessarily at the same rates. Four factors are necessary for transition between the stages. They are maturation, experience, social interaction and equilibration.

In the study of children's concept of number, Piaget (1952b) first investigated the way in which children arrive at the invariance of wholes and conservation of quantity, and then the problem of one-to-one correspondence leading to cardinal and ordinal meanings of number was carefully probed. Finally, in the same study, the way in which children combine classes and numbers additively and multiplicatively were investigated. Piaget's work on the child's concept of space (Piaget and Inhelder, 1956), showed that topological space is first appreciated by the child and that Euclidean space only appears later. While the study of the relationship between class and number is very appropriate nowadays with the teaching of sets in primary schools becoming widespread, the findings on

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Many of Piaget's experiments on his theory of children's concept of number, material, space and time have been replicated with children in many countries. In England, Lovell repeated some of the experiments and substantially confirmed the findings of the Geneva School.[60]

As documented by Judith Evans, [61] experimental studies into the cognitive process of the African child are recent occurrences. Only a few studies had been done before 1960 and it appears that the validity of most of them is doubted. However, there is a growing interest in this field, especially because it provides information about the universality of the existing theories in educational psychology, and also provides valuable understanding of the child's background and abilities when he enters school. A few of these recent studies have addressed themselves to some aspects of cognitive development of the Yoruba child of Western State, Nigeria.

Etuk (1967) conducted a Piaget-oriented study with selected Yoruba-speaking children of Western State. A standardized interview schedule based on Piaget's tasks was used to investigate the theory that conservation, seriation, and classification

[60] K. Lovell, The Growth of Basic Mathematical and Scientific Concepts in Children, London: London University Press, 1961.

[61] Judith L. Evans, Children in Africa (A Review of Psychological Research), New York: Teachers College Press, 1970.

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develop concurrently. Etuk also examined the relationship of the development of number concepts to intelligence, the effect of sex differences on the development of number concepts, and differences in performances of children from modern and traditional homes. Her results generally supported Piaget's theory. Etuk found only a slight relationship between intelligence and performance on number tasks. She found slight sex differences and that the children from modern homes performed at a higher level than their counterparts in traditional homes.

Of great significance to the issue of cognitive development and the African child is a recent Unesco sponsored seminar on the development of science and mathematics concepts of young children in African countries.[62] Emphasis was on "Piaget and Africa." Many published and unpublished studies involving conservations and classification with African children were reviewed and analyzed. Some studies of intercultural comparisons showed that African children were behind Europeans in their performance on the operatory tasks, but in no case were efforts made to check on the subjects' understanding of the problem.[63] Other intercultural studies, in which the method of indirect comparison were used found little or no difference between African and European performance.[64] The results

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[62] UNESCO/UNICEF, op. cit., p. 8.

[63] See bibliographic entries under: (1) Beard (1968), (2) Heron & Simonson (1969), (3) Vernon (1969), and (4) Goldschmid et al. (1973).

[64] See bibliographic entries under: (1) Prince-Williams (1961), (2) Lloyd (1971), and (3) Ohuche (1971).

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suggest that intercultural differences are least when the research involves: (1) subject from the elite class, (2) simpler task, (3) a flexible clinical method, rather than standardized interviews, and (4) an accomplished interviewer from the same culture as the third-world sample.

Over a period of more than ten years Gay and Cole and their collaborators have carried out series of investigations among Kpelle children of Liberia.[65] Their major tool has been ethnographic analysis through which daily activities of the Kpelle can be related to such cognitive activities as problem-solving, memorization, and rule learning. The researchers conclude that cultural differences in thinking indicate differing uses of general cognitive skills in specific situations.

A number of studies have investigated mathematical concepts development of the African child. Hill (1964) worked with Ghanian and American first grade children to look at the way they developed mathematical concepts. A trend in her data indicated that initially American children responded correctly to ordered sets, while Ghanian children responded correctly to identical sets. Hill hypothesized that each culture has produced a preferred concept and that knowing the preferred concept of a cultural group is important in designing the relevant mathematical experiences. Traditional mathematical concepts have also been investigated in Nigeria (Taiwo, 1968),

[65] John Gay and Michael Cole, The New Mathematics and An Old Culture (A Study of Learning Among the Kepelle of Liberia), New York: Holt, Rinehart and Winston, 1967, p. 30.

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erra Leone (Ohuche, 1973), and in Tanzania (Mmari, 1974). though most of these studies were very exploratory, findings om them should be of great value in investigating the types mathematical concepts with which rural and urban children Africa are equipped before they start school. They would so enable teachers to determine how to extend the social and ysical experiences of children in directions which will help em to cope with the demands of formal mathematical thought.

In all of the studies of cognitive development and mathe- ical concepts related to the African children many unresol- l problems present themselves and many data are not conclu- e. Among the unresolved problems are the issues of familiar unfamiliar materials used for the investigation, the lang- e of communication, the determination of subjects' age and classroom application of some of the findings. While there still the need for further research to verify some of the , present evidence seems to support what Inspector Cummings e in 1908 and what was further confirmed by Abiola,[66] that African child has great potential if only he can be accorded er learning experience through better and adequately train- achers. Abiola added:[67]

> It is not ability but inadequate environmental and educational factors that are responsible for the differential performance between the African and the European children on European-imported skill patterns.

6E.T. Abiola, "Understanding the African School Child," frican Journal of Education, Vol. 15, No. 1, February, p. 63-67.

Ibid., p. 64.

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After a review of mathematical concept development in non-Western cultures, including some of Africa, Hugh Philp luded that particular attention should be given to the fol- ng in the construction of mathematics curriculum:[68]

1. Curriculum should be process oriented, and methods should be heavily discovery learning based;
2. The learning processes and preferred strategies of each particular culture group should be carefully investigated and the curriculum built and teaching-learning methods devised in order to take account of them;
3. The linguistic structure of the mother tongue should be analysed to determine the classificatory system.

's conclusion is especially relevant to the present study aims in the long run not only to facilitate curriculum e, but also to help teachers change their instructional egies. More information on this type of curriculum is ded by the theory and research on instructional process.

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The focus on how children learn mathematics has given to new attempts to create a more appropriate learning

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[68]Hugh Philp, "Mathematical Education in Developing Coun- --Some Problems of Teaching and Learning," in: A.G. n (ed.), Developments in Mathematical Education (Proceed- of the Second International Congress on Mathematical tion), Cambridge: Cambridge University Press, 1973, 3.

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nvironment for children. According to DeVault and Kriewall,[69] workable theory of instruction must account for variables reated to four sources: learner, teacher, instruction and conent. That is, in addition to the diverse learner needs, a iable theory must account for teacher differences such as ersonality, education and roles; content variables, such as equence and structure; and instructional variables such as terials and equipment. The earlier part of this writing has amined teacher education and personality, and the learners' aracteristics. This section deals with the issue of instruconal modes relevant to mathematics teaching.

The general psychological foundation of many of the new proaches to mathematics instruction can be found in Bruner's oks: The Process of Education[70] and Toward a Theory of struction.[71] Bruner states that a theory of instruction ould have four major features:[72]

1. a plan for motivating the learner;
2. a plan for helping the learner grasp the structure of a body of knowledge;
3. a plan for sequencing learning activities;
4. a plan which designates the types and distribution of rewards and punishments.

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[69] M. Vere DeVault and T.E. Kriewall, "Differentiation Mathematics Instruction," in Mathematics Education, The ty-Ninth Yearbook of the National Society for the Study of cation, E.G. Begle (ed.), Chicago: The University of cago Press, 1970.

[70] Jerome Bruner, The Process of Education, New York: tage Books, 1973.

[71] ____________, Toward a Theory of Instruction, New k: W.W. Norton and Co., Inc., 1968.

[72] Ibid., p. 41.

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An examination of the literature shows that mathematics instruction has been evaluated to a great extent against these major ıssumptions. In addition, the term around which many of the ıssumptions and much of the new psychology of learning has ieveloped is "learning by discovery." Although the idea of .earning by discovery has been greatly associated with Bruner, .ts origin dates as far back as the days of Plato. Bruner, .owever, captured the spirit of discovery in the new mathemat-cs curriculum and communicated it effectively to both profes-ional and laymen through his books. Learning by discovery nvolves the formulation of questions or hypotheses by the earner, and the development of his own strategies to answer he questions.

Two other major theories of instructional mode that have elevance for primary mathematics instruction are the guided iscovery and expository theories. Guided discovery approach s opposed to pure discovery is when the child develops his n strategies for answering the questions with teacher's help needed. In the expository mode the problem is posed and swered externally and the child is expected to replicate e problem and solution or to work others which are similar. ctures and explanations are expositorily presented.

The guided discovery approach is closely associated with gne's theory (Gagne, 1965). For Gagne, learning is a goal, d how a behavior or capability is learned is a function of e task. It may be by discovery, by guided teaching, by practice, by dr

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practice, by drill, or by interview. The focus is on "learning" and discovery is but one way to learn something. Whereas for Bruner, it is learning by discovery. Gagne believes that one cannot master more complex material learning tasks until the fundamental elements have been learned. He advocates the importance of doing task analysis which begins by specifying the terminal objective. His idea of learning hierarchy and its many ramifications for analysis and development of instructional action is important for sequential learning in mathematics. For this reason, the method of programmed learning is very much associated with Gagne.

Ausubel's expository theory stands in counterpoint to the body of theory which advocates discovery approach over the expository approach. He maintains that the opposite of discovery learning need not be "rote learning," it ought to be meaningful verbal learning.[73] Like Gagne, Ausubel emphasizes the great importance of systematically guided process of instruction.

Evidence from empirical studies seems to be inconclusive as to which of the instructional approaches would make greatest contribution to facilitate the mathematics learning process for students. Cronbach (1966), for example, stated: There is precious little substantiated knowledge about what advantages teaching through discovery offers, and under what

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[73] David P. Ausubel, "Facilitating Meaningful Verbal Learning in the Classroom," The Arithmetic Teacher (February, 1968), pp. 126-132.

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onditions these advantages accrue. Since that time, some ther studies have investigated the issue. Shulman (1968) eviewed some of these studies, and made some general statements on the findings. In general, guided learning or expository sequences seem to be superior methods for achieving imediate learning. On the issue of long-term retention, neither pproach seems to be consistently better. Worthen (1968) compared task presentation through a discovery approach and an xpository approach. One of his conclusions was that discovery earning approaches appear to be superior when the criterion f transfer of principle to new situations is employed. His indings suggest that if pupil ability to retain mathematical oncepts and to transfer the heuristics of problem solving are alued outcomes of education, discovery sequencing should be n integral part of the methodology used in teaching. In genral, it appears from the published studies, that the guided iscovery approach has achieved best both at the level of mmediate learning and of later transfer.

The theories and related studies examined here show that ne mode of instruction is an important variable in teachingearning process; so is the teacher. Success or failure of nstruction is highly dependent upon the ability of the eacher to carry it out. Ausubel,[74] for instance, points out nat expository instruction can be meaningful instruction. owever, much of expository instruction in many classrooms is

[74] Ibid., p. 130.

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not meaningful. Ausubel maintains that that is the fault of the teacher, not of the mode of instruction. Similarly, it can be said that guided discovery can become rote learning in the hands of a less competent teacher. Therefore, teachers in their role as instructional facilitators assume a responsibility which requires some skills. The responsibility is more than just skill development for mathematics instruction. Children need enjoyable experiences which foster positive attitudes and instill natural curiosity about learning in general and particularly mathematics learning. Some teachers can probably develop these skills on their own. For a majority of teachers an inservice program that focuses on such needed skills would be most useful. More discussion on this type of inservice training program is provided next under the heading of inservice patterns and practices.

THEORY AND PRACTICE IN INSERVICE EDUCATION

Purpose and Philosophy

By inservice education is meant, all of the activities in which teachers may engage in order to improve themselves professionally while they actually are teaching. An examination of literature shows that inservice training has been used all through the history of formal education to serve a variety of purposes. These purposes vary from one society to the other, and according to the needs of the society, which the educational institutions have to respond to at a particular time.

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Johnston[75] identified twenty different purposes some of which are relevant to this study. These purposes are as follows:

1. Extension of knowledge.
2. Consolidation and reaffirmation of knowledge.
3. Regular acquisition of new knowledge.
4. Acquaintance with curricular developments.
5. Acquaintance with psychological developments.
6. Repetition or extension of original preservice education after intervals.
7. Acquaintance with new aids.
8. Introduction to new methods.
9. Understanding the new relationship between teacher and taught.
10. Acquaintance with and participation in education research.

The above list of objectives is by no means exhaustive but it indicates the wide range of inservice general objectives.

While these purposes may be regarded as societal or group purposes for inservice training, Corey[76] identified another purpose for inservice education--the purpose of the teacher

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[75] D.J. Johnston, Teachers' Inservice Education (The Commonwealth and International Library of Science Technology Engineering and Liberal Studies), Oxford: Pergamon Press, 1971, pp. 6-28.

[76] Stephen M. Corey, "Process of Inservice Education," in Reading in Inservice Education, Patel, I.J. and Buch, M.B. (eds.), Gamdi-Anand, India: Anand Press, 1968, p. 123.

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to improve his teaching. It is important to understand this purpose in order to place the whole process of improvement itself in the proper context, Corey added. Before a teacher undertakes to improve his teaching there must be some aspects of his teaching which he is dissatisfied with. The awareness of the need for improvement on the part of the teacher is an indicated readiness which is needed for the kind of help that inservice training can give.

A great deal has been written on theory and philosophy for inservice training of teachers, and in recent years publications on the improvement of inservice training have also increased.[77] Owing to the immense variety of publications most of the detailed references are tailored to the conditions in the United States.

Perhaps the most complete work on inservice education is the fifty-sixth yearbook of the National Society for the Study of Education, In-Service Education.[78] This publication contains everything from justification for inservice education to outlining specific programs. History, roles, programs, organization, evaluation, and so on, are discussed. In the chapter entitled, "Teachers and Inservice Education Programs," the author makes a point that inservice education should not be a program for making up teacher deficiencies, although this

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[77]See bibliographic listing under the following names for examples: (1) Bessent (1967), (2) Harris and Bessent (1969), (3) Johnston (1971), (4) Rubin (1971), and (5) Thornbury (1974).

[78]Nelson B. Henry (ed.) In-Service Education for Teachers, Supervisory and Administrators, Chicago: The University of Chicago Press, 1957.

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could be one of the functions of inservice education. The main theme portrayed in the publication is that great improvement in professional practices of teachers may be brought about by encouraging and assisting them to make a cooperative attack on professional problems of common concern.

More recently and closely related to the present study is the discussion of inservice mathematics education in the thirty-second yearbook of the National Council of Teachers of Mathematics (NCTM).[79] The discussion includes the development of "new" mathematics curricula, discovery teaching, the summer institutes, academic year institutes, establishment of the Inservice Education Committee of the NCTM, and state and local inservice programs. The chapter gives a general familiarity with total inservice movement for mathematics and the strong support received from the National Science Foundation.

Weaver[80] raises some basic issues concerning inservice training in 1963. Among them are: (1) What content should be taught? (2) Should subject matter be dealt with exclusively or should methodology be incorporated? (3) Should released time be provided? and (4) What about the physical set up? Some of these issues are still unresolved even today (1975), though Weaver's presentation of them provides a good checklist for the development of new inservice programs.

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[79] E.G. Gibbs, et al., "Inservice Education," A History of Mathematics Education, 32nd Yearbook, NCTM, Chapter 16, 1970.

[80] J.F. Weaver, "Inservice Education and the Teacher," The Arithmetic Teacher, Vol. 10, November, 1963, pp. 456-457.

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The general organization of inservice programs for effective classroom learning is the main target of Lippitt and Fox.[81] These authors emphasize the need for the teacher's involvement in his own learning. Not only do they suggest that, whenever possible, the teacher should participate in identifying the growth experiences which will be most useful to him, but also they suggest that the growth activities should assist the teacher to develop his capacity for self-direction at the onset. Although Lippitt and Fox do not rule out individualized learning, they strongly hold that the professional development of teachers must be seen in the context of a group process, of team relationships, and of total staff development.

In their argument against some of the weaknesses of some present day inservice approaches, Lippitt and Fox underscore two relevant issues. They emphasize that the design and management of an inservice education program must be done by someone who is intimately acquainted with the environment in which the teachers operate. Also, they stress the fact that better teaching requires more than familiarizing the teacher with something new: it requires fundamental changes in teacher's behavior.

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[81] Ronald Lippitt and Robert Fox, "Development and Maintenance of Effective Classroom Learning," in Improving Inservice Education, L.J. Rubin, (ed.) 1971, op. cit., pp. 133-169.

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Many methods and means have been employed for the provision of inservice education to elementary school teachers in many countries. In general, these activities are initiated in two ways. One kind of inservice education is highly individualized and is undertaken by a particular teacher on his own initiative and not as part of a "program" of inservice education made available to a number of teachers with similar needs. A teacher might improve himself on his own by reading books and journals, by getting help from his colleagues, by travel or by individual classroom experimentations, to mention but a few of the many possibilities. Although this study is devoted mostly to a consideration of programmed inservice education reference is made to the self-initiated approaches as they are often useful in enhancing and sustaining the group inservice work.

Among the common approaches to inservice education practiced in some countries in Africa are: late-afternoon classes offered by the school district using its best-qualified staff; university or college extension classes; week-end, summer, one-term and academic year institutes; conferences; films; television programs; and correspondence courses. An examination of selected inservice programs in some details gives an indication of the patterns and practices. Related research on program effectiveness is described where such evaluation has been carried out.

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Selected Practices in the United States:-In a comprehensive report of promising practices in inservice mathematics education, Schult and Abell (1963) documented approaches practiced in some school districts of twelve states, involving six professional organizations and departments of the U.S. Office of Education. The authors reported the achievements and some common problems on inservice organization. The problems include the selection of course content, materials of instruction, the issue of credit and non-credit courses, how to conduct correspondence courses and many others.

Inservice education in mathematics for elementary school teachers have, in general, been the workshop type. Because of the busy schedules of the school teachers and the consultants who lead the workshops, the workshops are usually of two categories: the "one-shot" type carried out over a short period of two or three weeks during the summer vacation or early in the fall term; and the "slowly-paced" type, which extends for a long period of about the school year.

(1) Short Term Courses:-Hunkler[82] described and evaluated a short-term or "one-shot" inservice course sponsored by a school district. The course was organized through five ninety-minute sessions, closely-spaced, and one course in a given year. The specific content of the teachers' course

[82]Richard Hunkler, "An Evaluation of a Short-Term Inservice Mathematics Program for Elementary School Teachers," School Science and Mathematics, Vol. 71, 1971, pp. 650-655.

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included ways by which teachers can help children towards the mastery of computational skills, number system and algebraic system. Secondly, the use of some teaching aids in modern mathematics were presented to the teachers. Sixth grade pupils who have been taught by teachers with or without the short-term course over a period of three years were studied in order to decide on the effectiveness of the short-term program.

Hunkler collected and analyzed data on the students' arithmetic concepts and problem-solving scores in terms of their grade equivalents on the Iowa Test of Basic Skills. His results led him to conclude that while short-term inservice mathematics programs are effective means of preparing sixth-grade teachers to teach arithmetic concepts when initiating a modern mathematics textbook, they are not effective means of preparing teachers to teach problem-solving in arithmetic.

(2) Long-Sustained Part-Time Courses:-A "slow-paced" inservice program in Dallas, Texas, during the school year 1960-1961, involving some 89 teachers and 1,977 of their pupils was reported by Houston and DeVault.[83] The 13-hour inservice program was organized via four methods of inservice education: (1) television, (2) television and consultant to teachers,

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[83]W.R. Houston and M.V. DeVault, "Mathematics Inservice Education: Teacher Growth Increases Pupil Growth," The Arithmetic Teacher, Vol. X, May, 1963, p. 243.

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(3) face-to-face lecture-discussion alone, and (4) face-to-face lecture-discussion and consultant to teachers. The content of the program was primarily related to important mathematics concepts for the elementary school. Aspects of historical development of mathematics and the relationship between mathematics and other selected areas of general education were included.

In evaluating the program, various tests were used, some as pretests and others as posttests for teachers and the pupils. Effort was made to control for the mathematics understanding of teachers prior to the inservice education. The researchers' main interest in this report seemed to be on the teacher and pupil variables and there was no reference to the effect of the different media of instruction used in the inservice program. However, they concluded that the inservice program was effective in increasing mathematics achievement both for teachers and their pupils.

Dutton and Hammond[84] made a study of two inservice approaches that were both paced out through the school year. The purpose of the study was to determine the effectiveness of two instructional plans for helping teachers understand the new mathematics. Emphasis was placed upon teacher understanding of the basic mathematical concepts and upon attitudes

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[84] Wilbur H. Dutton and H. Reginald Hammond, "Two Inservice Mathematics Programs for Elementary Teachers," California Journal of Educational Research, March, 1966, Vol. 17, pp. 63-67.

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It was hypothesized that the workshop using the college professor, a structured program, and a textbook would bring about more change in teacher understanding of basic mathematical concepts than would the informal district planned workshops. It was further hypothesized that the attitudes of teachers toward arithmetic would be more favorable in the structured program than in the informal program. The results showed that teachers in the informal program gained significantly more than teachers in the formal program. The amount of gain in mean score on post-test of teachers in the unstructured district program was almost double that of the structured group. The authors remarked that the reason for the difference might be found in the fact that the unstructured, district-staffed program, probably provided many opportunities for individual teachers to work on specific difficulties than the structured program did.

The results of attitude measures in the two groups was in reverse, with the structured district gaining from pretest to post-test, while there was a drop in attitude measure of teachers in the unstructured district. This result was unexpected and the authors wondered whether this was due to the group reinforcement found in the structured district.

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Nevertheless, Dutton and Hammond maintained:[85]

> Teachers' attitudes towards new mathematics (or mathematics) are important. Through the use of meaningful work in teacher workshop, teachers have a good chance to improve their own attitudes toward mathematics.

Furthermore, they emphasized that two major concepts should permeate inservice education to prepare teachers for the teaching of mathematics:[86]

> (1) provision of instruction which is meaningful and which will enable teachers to present mathematics so that children understand the structure of the number system; and
>
> (2) use of appropriate evaluation instruments throughout the workshop so that teachers will become involved in the same kind of appraisal techniques which should be used with children.

(3) The "Intermediary" Approach:-A third approach which has been called the "intermediary" approach by Ruddell and Brown[87] is also practiced. Unlike the first two approaches described so far, this approach is in two stages. The first stage is one in which a group of inservice leaders receive instruction from a consultant or consultants on a short-term basis. They, in turn, conduct inservice training for elementary school teachers, as a second stage. These leaders are themselves outstanding elementary school teachers, supervisors, and administrators with mathematical interests and aptitude.

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[85] *Ibid.*, p. 67.

[86] *Ibid.*, p. 67.

[87] A.K. Ruddell and G.W. Brown, "Inservice Education in Arithmetic: Three Approaches," *Elementary School Journal* (April, 1964), pp. 377-382.

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They are referred to as intermediaries since they act between the consultant and the classroom teachers.

Izzo and Izzo[88] described an actual situation in which this pattern was demonstrated in the State of Vermont during the summer of 1963 and the school year that followed. The summer institute for the intermediaries had as its objective the following:

1. learning the essential school mathematics subject matter recommended by CUPM,[89]
2. preparation for conducting an inservice program in mathematics, and
3. learning about the knowledge of effective approaches at the elementary level.

The thirty-one participants spent an intensive summer acquiring knowledge of the basic concepts of mathematics after which they returned to their school districts and carried out the inservice program.

The inservice program conducted by the intermediaries was similar to a class or a course with the summer institute participant as the instructor. Usually, the session lasted for about 1½ to 2 hours in a week all through the school year. The main objective was to help teachers develop better comprehension and appreciation of the structural aspects of mathe-

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[88] J.A. Izzo and Ruth Izzo, "Re-Education in Mathematics for Elementary School Personnel: Inservice Programs--One Way to Solve the Problems," The Arithmetic Teacher, Vol. XI, October, 1964, pp. 413-417.

[89] CUPM--Committee on the Undergraduate Program in Mathematics.

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matics. The content of the inservice covered a good many topics in the basic concepts of elementary school mathematics. Emphasis was placed on how the teachers could use the knowledge to improve their teaching. Analysis of textbooks and materials of instruction was part of the activity of the inservice education.

The evaluation of this program did not extend to the pupils taught by teachers who participated in the inservice program. In fact, the basic evaluation reported comments and reactions of the participants at different stages of the program. In general, they were all favorable comments.

Ruddell and Brown[90] evaluated the three approaches discussed so far, that is, the "one-shot," the "slowly-paced" and the "intermediary" approaches. The achievement of students taught by different groups of teachers were measured over a year's time. It was found that in grades three, four, five and six, significant differences between mean gains were shown at every level and in each instance the gain favored the pupils of teachers whose inservice sessions--ten half-days--were spread over the year. The researchers concluded that some type of direct contact between consultant and teacher is necessary to bring about change in teachers' mathematical knowledge and understanding. Furthermore, they claimed that teachers' mathematical knowledge and understanding can be changed just as much from an intense "one-shot" program as from a slowly

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[90]Ruddell and Brown, op. cit., pp. 377-382.

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paced, long-range program, but that the change is not reflected in the children's achievement. If a basic premise of inservice education is that teacher's growth increases pupils' growth, then it appears that a slow-paced program should be preferred to a one-shot course based on the above conclusion.

Another study at the first grade level gives added evidence that direct, well-spaced inservice program increases the achievement in mathematics understanding of teachers involved in such a program as well as of the students they teach (Ruddell and Barlow, 1963).

The evidence presented so far suggests that the resulting increase in achievement of students and teachers from an inservice program depends somewhat on the type of program carried out. Also, the evidence suggests that teachers who are in the process of changing are more likely to effect similar change or growth in the pupils with whom they work.

(4) <u>The Multi-Jurisdictional Behaviorally-Based Program</u>:-[91]While the approach described in this section has some similarities with the earlier approaches, it has a distinctive feature that is worthy of attention in planning a new inservice program. The program indicates how combined capabilities of the different human resources in a community can be used in attacking the problem of teacher retraining for

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[91]University of Maryland Mathematics Project, <u>Multi-Jurisdictional Behaviorally-Based Inservice Program for Elementary School Teachers in Mathematics, Final Report, 1969.</u> (College Park: University of Maryland, 1969).

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Concern over the large number of teachers to be "reached" and the rate of change in content and methods of mathematics led to the development of a model for the specification, development, and implementation of an elementary mathematics inservice education program to upgrade the mathematics teaching competency of elementary school teachers. The project was conducted by the University of Maryland Mathematics Projects, and the Maryland State Department of Education in collaboration with local school agencies.

The program is built on the belief that inservice programs can be fun and relevant, and that elementary school teachers can learn and enjoy mathematics. The course is designed for workshop sessions in which teachers work extensively with concrete materials and diagrams as they learn to make explanations for many different computational procedures. Each one of the courses for twenty-six sessions is an example of instruction presented as a game. The semi-programmed style of the courses makes it easily adaptable to individualized work. In addition, the games are presented in terms of behaviors to be demonstrated and are ordered on the basis of behavior hierarchies. In reviewing the final report, Joost Yff suggested that this mathematics inservice package offers an interesting alternative to traditional techniques for inservice teacher education.[92] He further reported that research

[92]Joost Yff, "Multi-Jurisdictional Behaviorally-Based Inservice Program for Elementary School Teachers in Mathematics. Final Report--A Review," The Arithmetic Teacher, Vol. 17, No. 7, pp. 610-611.

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findings indicate that the material does work when used with elementary teachers in inservice training.

(5) Some Critical Issues:-The literature examined up to this point generally indicates that inservice programs are effective means of helping teachers acquire the needed background for mathematics teaching, even though one approach may be more effective than another. However, some other studies tend to negate some of the claimed effectiveness of some of the approaches employed.

Do pupils actually benefit from certain types of inservice programs for their teachers? Norris[93] describes a study conducted with sixth-grade teachers who were using a contemporary textbook which included mathematical content to which they had not previously been exposed. Teachers in the experimental group had a one-shot inservice lecture on the mathematical concepts they would be teaching during the school year, whereas the comparison group had to cope with the new ideas as they encountered them in the pupil's textbook. Teachers and pupils were given achievement tests, and the effectiveness of the inservice programs was determined by the mathematics achievement of their pupils over the school year. Norris notes that the significantly greater gain by the pupils of the teachers in the experimental group tends to negate the idea that learning-while-teaching is wholly satisfactory.

[93] Fletcher R. Norris, "Students Mathematics Achievement as Related to Teacher Inservice Work," The Mathematics Teacher, Vol. LXII, No. 4, April, 1969, pp. 321-327.

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The reports of Hand[94] and Creswell[95] are also examples of negative views on the effectiveness of inservice training. Hand, in a study of 348 elementary teachers found that the achievement of first, third and sixth-grade students whose teachers were inservice participants did not differ significantly from those students whose teachers were not inservice participants. Creswell in an article concerning the effectiveness of mathematics workshop concluded that college courses are far more effective in preparing teachers to teach modern mathematics than workshops. Creswell's evaluation and conclusion, however, have no reference to pupils' gain.

Weaver,[96] as mentioned earlier, raised the issue of whether inservice programs should deal exclusively with subject matter or whether content and method should be integrated. A few studies have demonstrated the effectiveness of the integrated content-method or workshop approach to mathematics inservice programs. Among them are Dossett (1964), McLeod, (1965), and Hunkler and Quast (1972). Dossett analyzed the effectiveness of a workshop approach for the improvement of mathematical understanding, changing attitudes towards mathematics and for improving classroom practices. She concluded that workshop participants made significant gains between pre- and

[94] E.F. Hand, "Evaluation of a Large Scale Mathematics Inservice Institute for Elementary Teachers," Unpublished Doctoral Dissertation, University of Georgia, 1967.

[95] John L. Creswell, "How Effective are Modern Mathematics Workshops?" The Arithmetic Teacher, Vol. XIV, 1967, pp. 205-208.

[96] J.F. Weaver (1963), op. cit., pp. 456-457

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post-test on tests of mathematical understanding and on arithmetic attitude inventory. McLeod's study explored the desirability of several means of presenting both mathematical concepts and teaching methodology to experienced teachers including the combined method-mathematics program. The conclusion reached in her study was that the combined method-mathematics-experience design of inservice program was an effective and efficient way of meeting mathematical needs of the elementary school teachers. Similarly, Hunkler and Quast, working with preservice teachers, came to the conclusion that that their three-semester hour method-content mathematics course improved mathematics attitudes of prospective elementary school teachers.

The major theme of Rickey's[97] paper is on the issue of released time, either during the school year or during summer. Rickey explained how Dade County in Florida handled the problem by giving teachers released time and teachers earned while they studied. An explanation of the program, its financing and the selection of participants were also given.

The literature points to some promising practices in inservice training as well as some unresolved problems. Investigation after investigation has stressed the need not only for teachers to "grow on the job" but also the need for studies which further investigate the effectiveness of different forms

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[97] Agnes Rickey, "Teachers Earn and Learn," The Mathematics Teacher, Vol. LX, No. 6, October, 1967, pp. 638-640.

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of inservice education. Some of the existing evidence seem to present conflicting views. There is need for continued evaluation of the different approaches to inservice training if such retraining programs are to meet the needs for which they are planned. Meanwhile, as Dutton and Hammond asserted, it is important to plan inservice education in terms of the specific weaknesses teachers have as determined by a diagnostic process.

A look at some other environments shows similar successes, failures and unresolved issues in inservice education practices.

The British Teachers' Centers:-In the words of Edith E. Biggs, "If teachers are to provide opportunities for their students to learn mathematics through firsthand experience, they must first be convinced that this is possible."[98] The campaign for mathematics inservice training for elementary teachers in Britain followed closely the shift in emphasis from teaching to learning in mathematics. According to Biggs, the first teachers' centers were set up in the rural county of Dorset in 1963.[99] The first centers, used as classrooms by day, became rooms where teachers could meet at regular intervals during the evening to discuss difficulties and

[98] Edith E. Biggs, "Mathematics Laboratories and Teachers' Centres--The Mathematics Revolution in Britain," in R.B. Ashlock and W.L. Herman, Jr., Current Research in Elementary School Mathematics, New York: The MacMillan Co., 1970, pp. 298-309.

[99] Ibid., p. 306.

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successes in their experiments in mathematics in the classroom. Teachers also learned mathematics by discovery methods themselves at such meetings. By 1966, through the help of the Nufflied Mathematics Project nearly a hundred centers had been set up in mathematics, in science, or in both.

The leader-teacher, whose role is similar to that of the intermediary personnel, as examined in the United States, receives inservice course from the consultative areas and later works with his small group of teachers in his center. Most centers require some help from time to time and they call on lecturers from colleges of education, on other centers, or on Her Majesty's Inspectors of School. The British Department of Education and Science has organized an increasing number of the courses in mathematics each year, not only to bring together all those concerned in the learning of mathematics, but also to appraise methods and content and to encourage work at new centers as these are set up.

Although other forms of inservice programs are practiced, the Teachers' Centers have played a significant part in inservice mathematics training. A government survey on inservice training drew attention to "the important part played even in 1966/67 by teachers' centres, where nearly ten percent of all courses were held."[100] The centers help in solving some of

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[100] Department of Education and Science, Statistics of Education, Special Series No. 2, Survey of Inservice Training for Teachers, 1967, London: Her Majesty's Stationery Office, 1970, p. 10.

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the problems involved in the location of inservice programs. Teachers want inservice training close to their own home or school and the teachers' centers offer this opportunity. This type of local course is called for more and more in addition to the national or regional programs.[101]

Biggs[102] asserted that the mathematics inservice held at the centers became more effective from the time teachers took an active part in the planning. Teachers explore the possibility of using materials from the environment as well as structured materials for mathematics teaching. They prepare topics and problems for use with children they teach.

On a more national basis the Joint Mathematics Council of the United Kingdom handles some of the problems of teacher retraining for mathematics teaching. In its Report on Inservice Training of Teachers of Mathematics, the Council analyzed the situation and explained some of the problems of inservice organization by stating:[103]

> -- that the numerous activities carried out to date have brought in only the most enthusiastic fraction of teachers;
> -- that the organizers and their helpers, often unpaid, could not extend their activities owing to the lack of time and resources;
> -- that the majority of teachers are not capable of coping with the situation unaided.

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[101] Robert Thornbury (ed.), Teachers' Centres, New York: Agathon Press, 1974, p. 11.

[102] Edith Biggs, op. cit., p. 307.

[103] Joint Mathematical Council of United Kingdom, Report on Inservice Training of Teachers of Mathematics (1965), in: W. Servais and T. Varga (eds.), Teaching School Mathematics, A UNESCO Source Book, Paris, UNESCO: Penguin Books, 1971, p. 248.

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In order that the training may be available to many teachers, the Council then recommended the establishment of local education authority mathematics centers, regional advisory units, a national committee, and a national information center. Here, again, is another example to indicate a great deal of cooperation and coordination on the part of school administrators, mathematics consultants, teachers and local community to bring about a truly effective mathematics inservice training program.

Some Patterns in Africa:-Many methods and techniques of inservice teacher training have also been practiced in different parts of Africa. Trevaskis[104] reviewed about twenty-five different approaches in English-speaking Africa alone. These methods include informal ones such as guided reading, circulated materials, use of tape recorder and radio broadcast, as well as formal approaches such as direct teaching by radio, inservice center courses, general workshops, teacher training college courses, and other courses with external assistance. The problems besetting the programs are as varied as the programs themselves. Among them are the lack of evidence to indicate the validity of any of the methods as an effective method of inservice training, and the lack of effective coordination of the resources available in a particular country.

[104] Graham A. Trevaskis, Inservice Teacher Training in English-Speaking Africa (A Report Prepared for the Afro-Anglo-American Programme in Teacher Education), New York: Teachers College, Columbia, 1969, p. 113.

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Trevaskis analyzed different aspects of the problems. In particular, he summed up the problems of program evaluation, and among his findings are that:[105]

(1) the objectives of most programs have not been clearly stated or defined;

(2) evaluation has not formed part of the planning procedures for a course, a series of courses, or an inservice programme;

(3) evaluation of the performance of participants has been carried out by personnel who were unfamiliar with its objectives.

In his final conclusion, he wrote:[106]

> The picture of inservice teacher training in Africa presented by this survey indicates clearly a pattern of problems, modes of action, and a wide variety of resources being brought to bear on improving the quality of teachers at all levels. But nowhere is there evidence of a clearly defined policy being systematically pursued. At the same time, evidence points to the desirability and possibility of a policy which could integrate inservice teacher training on the one hand with the preservice teacher programmes and on the other hand with the efforts being made to improve the curriculum and the quality of education.

Specifically, a mathematics training program for East and West Africa to implement the work of the African Mathematics Program was begun in 1970. The West African Regional Mathematics Program includes Ghana, Liberia, and Sierra Leone.[107]

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[105] _Ibid._, p. 136.

[106] _Ibid._, p. 151.

[107] J. David Lockard (ed.), _Eighth Report of the International Clearinghouse on Science and Mathematics Curricular_

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In general, the program is intended to make possible the implementation of primary school mathematics curriculum reform by training middle level personnel who will be responsible for preservice and inservice teacher education and at the same time, to make available suitable local primary materials which will be used in this implementation. Nigeria did not participate in this program.

Little has been reported on any systematic inservice mathematics education for primary school teachers in Western State, Nigeria. The Teachers Vacation Course, referred to in Chapter II still reaches a few teachers, but there is no emphasis on retraining for mathematics teaching. Some innovative attempts at inservice training have been made in the past; they seemed to have met with some or all of the problems identified by Trevaskis. For example, a previous attempt to establish inservice training centers in the Western Region in 1964 seemed to have achieved little success.[108] Some centers were closed down within a brief period of operation, partly because of location problems. A few teachers were interviewed on their use of the centers:[109] In addition to reading for personal development, five teachers mentioned obtaining books for their pupils, one mentioned preparing for an examination

Developments, 1972, College Park, Maryland: University of Maryland, 1972, pp. 48-51.

[108] R.M. Smith, "How Nigerian Teachers Use Inservice Centres," West African Journal of Education, Vol. XI, No. 2, June, 1967, pp. 72-74.

[109] Ibid., p. 74.

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and one was said to be in the habit of procuring books for his own children. Of the twenty-three teachers interviewed on their reading preferences in the centers only one mentioned arithmetic as a reading preference.

Western State of Nigeria was treated as a regional unit in Trevaskis' survey in 1969, and he reported the non-existence of mathematics inservice training of primary school teachers for curriculum implementation.[110] Similarly, the report of Wilson indicates that:[111]

> Much of the inservice training is ad hoc, and often on the initiative of the institutes of education, rather than of the State Ministries.

And yet, he adds:

> The introduction of a modern mathematics curriculum into the schools must be accompanied by a systematic programme of inservice training for teachers involved.

The literature reviewed here points to need for a rethinking and a reorganization for a systematic mathematics inservice program for primary school teachers in the state.

The Mass Media and Inservice Mathematics Education:-Instructional television and other mass media are being used increasingly to contribute towards the solution of a great variety of educational problems in many parts of the world, especially in the developed countries. Literature is rich

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[110] G.A. Trevaskis, op. cit., p. 28.

[111] B.J. Wilson, Nigeria: Mathematics, A Report Given to the Professional Division of the Federal Ministry of Education, Lagos, Nigeria, June, 1971, p. 15.

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in examples of the use of television programs as a pattern of inservice mathematics programs. Woodby[112] reviewed as many as nine programs as far back as 1962, all of them with some degree of success. Mathematics inservice training through the television in South Carolina (Bair, 1967) also illustrated some advantages and some challenges. The list can be continued. Bair remarked in his evaluation that despite the fact that television adds to cost, it may well be that the combination of resources which television demands, and the distribution of those resources to more teachers than can otherwise be reached should, in the long run, prove to be the most efficient way to enhance the quality of inservice education.

In the United Kingdom, both television and radio are being used for mathematics lessons. The BBC has transmitted special programs for teachers in mathematics.[113] Closed circuit television has also been used to familiarize hundreds of teachers with mathematical concepts.[114] Although there are no hard data in the reviewed literature, Johnston claimed that these programs have contributed to the rate and growth of inservice provision.

Some bold attempts have also been made in the less developed countries with a great degree of success. Television was

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[112] Lauren G. Woodby, "Television for Inservice Education," Audio Visual Instruction, Vol. 7, March, 1962, pp. 150-151.

[113] I. Woolf, "Television in Mathematics Education--Statistics In Perspective, BBC Further Education through Television," Times Education Supplement, 3097:69, October 4, 1974.

[114] D.J. Johnston, op. cit., p. 6.

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116 Ibid

used to prepare teachers for the teaching of unfamiliar subjects such as mathematics in Columbia, and it has proved to be an excellent inservice tool.[115] Schramm stated that the amount of learning was high, but it could be higher if teachers met in groups and discussed the broadcast lessons, and still more if the group had competent supervisors to direct the discussion. Ivory Coast has used television though not for inservice training but for literacy programs. Western State of Nigeria had school television broadcast early in the 1960's but this has since been discontinued.

Schramm[116] emphasized the need for a careful consideration of goals and means in launching the use of television or any media for educational change. He added that whether in the developing or developed countries, television has worked most effectively when it is integrated into a teaching-learning system and not when it is used alone, or when it is used as an optional visual aid.

There are many approaches to inservice mathematics education. Accordingly, local centers and national bodies have contributed to such programs in many countries. The promotion of mathematics teaching through inservice programs seems not to be a matter of once-and-for-all reform. There is evidence

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[115]Wilbur Schramm, "Instructional Television Around the World," in H.J. Klausmeier and G.T. O'Hearn (eds.), Research and Development Toward the Improvement of Education, Madison, Wisconsin: Dembar Educational Research Services, Inc., 1968, pp. 89-94.

[116]Ibid., p. 93.

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THEORY AND RESEARCH ON PLANNED EDUCATIONAL CHANGE

The literature on planned change is wide in scope and vast in quantity. Havelock (1969) reviewed approximately 4,000 sources in his analysis of the theoretical concepts and the research evidence dealing with change in education, agriculture, medicine and other fields. This section of the review discusses the major theoretical perspectives on change, the specific research studies that deal with helping teachers change their behavior, and the implications of this research for inservice programs.

The many theoretical models of the change process in education ranges from the research-development-diffusion perspective, associated particularly with Guba (1968), to what Havelock (1969) calls the human relations tradition of planned change, with its emphasis on group dynamics. Although these models vary considerably, yet they all deal with the same basic elements that are involved in educational change, namely: the client system (teachers, in the present study), the social structure of the school, the change agent and his relation to the teachers, and the characteristics of the innovation itself.

A number of studies have investigated the difficulties of helping teachers change their classroom practices. One of the most extensive of these studies, reported by Goodlad, Klein, and As

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Klein, and Associates (1970), deals with 158 classrooms in 67 urban elementary schools in 13 states of the United States. The researchers investigated teachers' implementation of new ideas in several areas, including the use of objectives, inquiry teaching, individualization, group dynamics, and modern mathematics programs. The findings were consistently negative. In spite of the fact that teachers often said they were individualizing instruction or using inquiry methods, for example, observers did not see these practices being implemented in the classroom. Instead, what the observers saw consisted of teachers "completing topics" rather than teaching towards specific objectives, teachers conducting class in large groups with almost no individualization, and teachers controlling all student interaction, with no opportunity for small group work. In fact, student interaction was said to have been largely discouraged in some cases. There was some evidence of curriculum change, particularly in mathematics; but in spite of the emphasis on <u>new content</u> in mathematics being taught, the <u>old teaching</u> practices still prevailed. This study indicates that teachers are not implementing new ideas in their classrooms, even when they seem to believe that they are; this fact underlines the important role that inservice training must play in helping teachers change their behavior. Appropriately, inservice plan should include such a goal.

Another study of educational change in the elementary school which

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school which has great relevance to the present study is the one cited by McLeod.[117] In this study of an experimental school, teachers were asked to change their role to make it more non-directive. The teachers, administrators and the community were all in favor of this change initially, and yet it was a failure within six months. Most of the teachers had given up on the innovative techniques by the end of the sixth month. Gross believes that the main reason for this failure was lack of continued support and training for the teachers during at least the first few months of an implementation program that wants to change teacher behavior.

In another study of change, Calson (1965) reported that the teacher's desire to perform in the role of a lecturer often caused inappropriate use of programmed instruction. Rather than letting children proceed at their own pace, teachers tried to slow down the faster students and speed up the others, apparently so that the students could be taught in a large group, thus satisfying the teacher's desire to perform as a lecturer. Again in this case there was no substantial inservice training program and the innovation was not implemented successfully.

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[117] N. Gross, The fate of a major educational innovation. Paper read at the Conference on Improvement of Schools through Educational Innovation sponsored by the Wisconsin Research and Development Center for Cognitive Learning, Madison, October, 1969, cited in: D.B. McLeod, The Effectiveness of an Inservice Program for Implementing an Activity Approach to Learning Mathematics in the Elementary School, Madison, Wisconsin: The Wisconsin Research and Development Center of Cognitive Learning, University of Wisconsin, 1972, p. 19.

Considerable concern is being expressed in many quarters over the relatively small number of innovations that survived after their newness had worn off. Arnold and Goodloe[118] conceded that the amount of change that has occurred in schools is unimpressive when compared to the financial and human resources devoted to the change effort in recent years. They discussed the following as factors present in successful attempts to change school programs significantly.

1. The innovation is a response to a locally recognized educational need or problem;

2. The relationship between the innovation and the problem it is to attack is clear to administrators, teachers, policy-making boards, and parents;

3. The innovation is an appropriate response to the defined problem;

4. The local school is making a significant investment of resources in the project;

5. The school staff understands the rationale for the innovative program and is adequately prepared to perform the tasks required for its success;

6. Supplementary services are adequate to support teachers in the classroom during the initial stages;

7. The evaluative criteria are appropriate to the innovation and are applied during the course of the program as well as its conclusion;

8. The innovation program is started on a manageable scale;

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[118] D.S. Arnold and A. Goodloe, "How to Innovate Successfully," Todays Education, the Journal of National Education Association, January-February, 1974, pp. 62-66.

9. The program leadership is capable and remains relatively unchanged throughout the implementation period.

Though this study focuses mainly on inservice mathematics education, the above guidelines for successful innovative process have great implications for the design of any teacher retraining program.

All the studies of educational innovation cited here have shown the difficulties involved in changing teacher performance. It appears that a well-planned inservice training program would be a reasonable way to improve the chances for success of an innovation. Also, when the innovation is a complex one involving a substantial change in the behavior patterns of teachers, the inservice programs should continue for several months after the teachers start using the innovation. By so doing, the inservice program can deal with the difficulties that teachers may encounter as they attempt to adapt their teaching to the requirements of the innovation.

SUMMARY

The literature reviewed has touched on theory and research on the learning and teaching of mathematics; theories, patterns and practices in inservice training; and some guidelines for planned educational change. When taken as a whole, the literature seems to reveal the following major findings:

1. Elementary school teachers can and do benefit from a variety of inservice programs in mathematics and in other aspects of the curriculum.

These inservice activities include: workshops, university and college courses both on and off the campus, short and long courses, institutes, conferences, television and radio courses, and correspondence courses.

2. The pupils of the elementary teachers who have participated in inservice programs in mathematics are favorably affected in their accomplishments in elementary school mathematics. Understanding their process and cultural background enhances teacher's possibility of success in teaching.

3. The planning of an inservice program should be conducted with teachers in an informal and relaxed atmosphere. Training program should be located as close as possible to teacher's place of work.

4. Inservice programs likely to be most effective are those directly concerned with the classroom problems of the teachers involved.

5. Inservice programs should be carried out within the setting in which the teachers normally work together. Using the inquiry method, teachers can effectively learn to identify and analyze their own problems and participate in achieving solutions.

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5. Inservice programs should be carried out within the setting in which the teachers normally work together. Using the inquiry method, teachers can effectively learn to identify and analyze their own problems and participate in achieving solutions.

6. When teachers are involved in the initiation and organization of training activities, conditions are enhanced for peer support, shared effort, and eventual utilization of new insights and skills.

7. Teachers who are in the process of changing are more likely to effect similar change in their pupils. Therefore, a long-sustained inservice program is likely to be effective.

8. Retraining programs should provide the teacher with the opportunity to learn to use materials from his environment as well as structured materials for mathematics teaching.

9. Personnel resources for inservice training reside in a variety of locations, including people within the local system, district consultants, university consultants, national educational consultants, and teachers themselves. All resources should be collaborated to provide leadership for inservice training.

10. There must be a framework to provide continuity of action and assurance of support, if efforts to change the performance of teachers are to succeed.

11. For an effective inservice program such framework should portray the following elements: (1)

identification of pressing needs, (2) establishment of goals, (3) setting of specific objectives, (4) selection of activities and schedule of sessions, and (5) plan for evaluation of outcomes.

The next chapter reveals the findings of an attempt to identify the needs of teachers for inservice mathematics training, their classroom practices and problems with the teaching of arithmetic, and their views and preferences for inservice training programs. Other related views and preferences are also discussed.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF SURVEY DATA

This chapter presents the survey data, the analysis of data, the findings and discussion based on the analysis. It consists of six sections:

1. The participating schools;
2. Problems of arithmetic teaching in schools;
3. Characteristics of teachers relevant for consideration in inservice design;
4. Teacher past participation in mathematics inservice training;
5. Teacher attitude towards mathematics activities and classroom practices;
6. Views and preferences on mathematics inservice programs: teachers, headmasters and organizers.

The chapter ends with a summary of findings.

In some sections, the interpretation of findings is discussed along with the findings, while in others they are presented separately. Such discussions are attempts to find clues to some issues related to the design of inservice mathematics education, reflecting on the findings from literature, the social and cultural setting of the study area, and other aspects of the educational setting of the study area known to the investigator.

PARTICIPATING SCHOOLS

As indicated in Chapter I, the teachers and headmasters included in the survey were found in 80 urban and rural schools of the Western State. While the teachers' questionnaire gathered information from the 380 teachers in the survey, the headmasters' questionnaire collected information on the total school group, the school location and the physical facilities for mathematics instruction.

Findings

Schools vary widely in location and in size as judged by the number of teachers in the schools. They are found in 30 towns, located in 25 administrative divisions of the state. There are 68 schools in urban areas and 12 schools in rural areas. Most schools are within 50 miles of a Teacher Training College or a Divisional Headquarter. Specifically, 95 percent of schools in the study are less than 50 miles distance from a Teacher Training College, while 99 percent are less than 50 miles distance from a Divisional Headquarter.

Headmasters' response shows a total teacher population of 1,565 in all the 80 schools. Total number of teachers in a given school ranged from a maximum of 39 teachers in one urban school to a minimum of six teachers in a rural school. Average number of teachers per school was 19. Figure 3 shows a distribution of these teachers by qualifications. A majority of teachers, or 63 percent, forms the group of the Grade II and Grade III teachers, the stratified group from which the

survey sample of teachers was drawn.

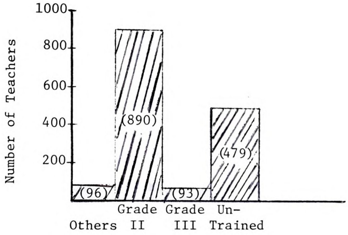

Figure 3. Total teacher population in 80 schools by qualifications.

Of the 80 headmasters, 63 (79 percent) had no teacher who had participated in any mathematics inservice program since he became the headmaster of the particular school. Ten percent had one or two teachers who had such previous participation and 11 percent had three or more teachers who had attended a refresher course. The headmasters had been heads in the schools for an average period of 2.03 years with a standard deviation of 1.89 years. Only three headmasters had been heads of their respective schools for more than six years. The maximum period of headship is 12 years.

The actual survey group includes these 80 headmasters and 380 Grade II and Grade III teachers, sampled from among their total number of teachers. Table 1 shows a breakdown of headmasters and teachers in the survey by geographical locations.

TABLE 1
Participating Teachers and Headmasters

	Urban		Rural	
	No.	Pct.	No.	Pct.
Teachers	317	83.4	63	16.6
Headmasters	68	85.0	12	15.0
TOTAL	385	83.6	75	16.4

Discussion

One of the basic theories of inservice design is to help teachers develop a group spirit with which to challenge a common instructional problem. The data analyzed above gives a general description of the total group of teachers in the 80 schools included in the survey. This general overview of the schools indicates an added challenge for inservice training. Many teachers have never attended any mathematics inservice program, as reported by the headmasters. Although the study is not directly involved in the issue of the untrained teachers in the 80 schools, the number of untrained teachers is large enough to be a matter of concern for inservice training. The mathematical background of the untrained teachers is not known. However, from the earlier discussion on teacher education program in the Western State, it appears that these teachers might be equally deficient, if not more deficient than Grade II or Grade III teachers in their mathematics background.

One wonders whether the relatively short period of headship has any effect on the data presented, since headmasters had to indicate the number of teachers who had participated

in mathematics inservice training since they became heads of the particular schools. The teachers' response in a later section should shed more light on the question of previous inservice participation of teachers.

The success of any inservice program depends to a great extent on various kinds of physical facilities such as a convenient place of meeting, a library, conference rooms, different writing and mimeographing materials, communication media and various teaching aids. Only 26 percent of schools have radios. If the mass media of this type should be used to supplement or complement inservice programs, as it has been used successfully for educational instruction in many parts of the world, then there is the need to consider its availability to teachers, especially teachers in the small rural schools. Another aspect of the physical facility is that of possible locations for inservice meetings. Most schools are within 50 miles of a Teacher Training College or a Headquarter. The choice of 50 miles was made on the knowledge that this distance could be travelled, if need be, by the use of a public transportation in approximately one hour.

This finding suggests that the 23 Teacher Training Colleges and a chosen school building in a divisional headquarter are potential locations for inservice programs. Further consideration of physical facilities is continued in different forms in the following sections.

PROBLEMS OF ARITHMETIC TEACHING IN THE SCHOOLS

In recognition of the fact that the problems of arithmetic teaching are not limited to a given classroom in a school, the headmasters in the sample were asked to state some of the problems they had with arithmetic teaching in their schools. Table 2 gives the summary of responses of headmasters by geographical location of schools.

TABLE 2
Problems of Arithmetic Teaching as Identified by Headmasters in Urban and Rural Schools, by Percentage Count of Responses

Problems Listed	Urban Headmasters (%)	Rural Headmasters (%)
Lack of qualified teachers......	38	42
Lack of teaching aids...........	91	92
Lack of up-to-date texts and teachers' guide................	82	62
No provision for inservice training of teachers................	32	59
Lack of materials for the teaching of metric system...........	34	67
Children's poor reading ability.	9	17
All others......................	12	8

No response from three urban headmasters in each case.

Although the small size in number of the rural schools did not allow for a rigorous statistical test of difference on this item, the indicated percentage counts in Table 2 portray slight differences in the problems of urban and rural schools. The data suggest that urban schools have better

provision of inservice training and of the supply of materials for teaching metric system than the rural schools. The rural schools seem to have greater need for qualified teachers than the urban schools. The problems of materials of instruction including teaching aids and textbooks are very acute in both areas. These findings support the earlier issues raised on the instructional practices in Chapter II.

A more detailed analysis of the problems classified as "all others" reveals some of the subtle problems involved in the teaching of arithmetic in the state's primary schools. About seven headmasters cited problems involving specific arithmetic topics such as fractions, decimals, area of circle, multiplication table, capacity, weights and metric system. In relation to materials of instruction, further problems mentioned had to do with the content of some textbooks. A few headmasters felt that there were insufficient practice sums in some of the existing textbooks.

Headmasters also mentioned problems related to instructional mode and children's learning style. As one headmaster clearly put it: "Arithmetic is not taught practically, teachers do not use apparatus." And still another headmaster wrote, "Children find it difficult to solve problems. They count fingers up to Primary VI." Embedded in these statements are grave instructional problems which need to be corrected in order to achieve meaningful arithmetic teaching in the primary schools. They range from problems of inadequate materials of

instruction and that of a lack of understanding on the part of the teacher of the structure of arithmetic to the absence of insight into children's learning mode. The teachers need help in order to make their teaching more practical and meaningful, and in order to be able to understand and help the child who still "counts his fingers" to do his sums in Primary VI, or in any other class.

Another crucial problem of arithmetic teaching in Western State primary schools pinpointed by the headmasters is best expressed in the words of the headmaster who wrote: "Teachers and pupils have poor understanding of English and this affects arithmetic." Reference had been made earlier to the intricate link between language and mathematics instruction. Even in societies where bilingualism is not a problem, the role of language in mathematics instruction is a matter of great concern. In the Western State, arithmetic is taught bilingually from the very first grade. Children are made to recite the number of names not as: "one," "two," "three," ... but as "one - okan," "two - eji," "three - eta" and so on. That is, the number names are repeated first in English and next in Yoruba or the child's mother tongue. This burden of learning arithmetic via two languages continues throughout different aspects of arithmetic learning in the lower grades. However, in the upper grades, the medium of instruction is officially English, though in practice bilingualism still continues. There is no doubt that the deficiency of teachers in

English language has a grave interplay on their arithmetic teaching and confounds the original problem of poor mathematical background of teachers.

The gravity of the problem of the medium of instruction in Western State primary schools is not only limited to its effect on arithmetic teaching but on the primary curriculum as a whole. Because of the gravity of this problem, some educators in the state are considering more and more the possibility of the introduction of a policy that would introduce the use of the mother tongue -- Yoruba in this case -- as the medium of instruction throughout the six years of primary education. The implication of such a policy is that arithmetic will be taught in the mother tongue and it is hoped that this might reduce some of the problems of the language medium on arithmetic teaching. The large scale experiment at the Institute of Education, University of Ife, Nigeria, usually referred to as the "The Six-Year Primary Project in Yoruba as the Medium of Instruction and English as a Second Language," is an outgrowth of such a concern.[119] The project is in its sixth year with its first generation of primary school graduates almost ready to complete the six-year project. The design of a mathematics inservice program for primary school teachers in the state must borrow selectively from some of the findings of this on-going experiment

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[119]A.B. Fafunwa et al., "A Mid-Way Report on the Six-Year Primary Project," Institute of Education, University of Ife, Ile-Ife, Nigeria, 1973

in order to make inservice programs related to the needs and problems of the schools and the society.

Finally, an administrative problem was raised by five headmasters as one of the problems of arithmetic teaching in the schools. It is the issue of the frequent transfer of teachers from one school to another. Continuity of learning experiences is essential to meaningful mathematics learning. The frequent transfer of teachers breaks such continuity. In addition, too frequent turnover of teachers interrupts the child's socialization process which is an essential human aspect for any learning situation.

The problems of arithmetic teaching given by the headmasters seem wide in scope. Nonetheless, they are all intricately connected to the teaching of arithmetic in the classroom.

CHARACTERISTICS OF TEACHERS RELEVANT FOR CONSIDERATION IN INSERVICE DESIGN

Teachers in the present study were categorized under certain characteristics in order to describe some of their attributes relevant to inservice training. Also the relationship between some of these characteristics and their expressed views on inservice programs was investigated.

The data show a wide range of differences in teachers' years of teaching experience and the classes they teach. The years of teaching experience ranged from 1 to 33. The mode and median years of teaching experience were 15 years and 14 years respectively, with the majority of teachers falling in

the 11 to 15 years category. Figure 4 shows the distribution of teachers by years of teaching experience. Only 18 percent of the teachers fall in the "new" group of one to five years range. This finding suggests that inservice programs should consider individual differences in "old" as well as "new" teachers. The study of Huettig and Newell[120] on the attitude of teachers with large and small number of years' experience towards the introduction of mathematics supports the need for this type of attention. Teachers with large number of years' experience (21-40 years) in their study reacted less positively than newer teachers (2 to 9 years of experience) to mathematical statements designed to measure their reactions. The differences were significant enough that these authors suggested special attention for "older" teachers in inservice training programs.

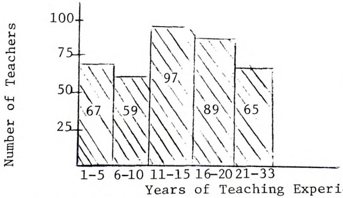

Figure 4. Categories of teachers by years of teaching experience.

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[120] Alice Huettig and John N. Newell, "Attitudes Towards Introduction of Modern Mathematics Program by Teachers with Large and Small Number of Years' Experience." _The Arithmetic Teacher_ (February, 1966), Vol. 13, No. 1, pp. 126-129.

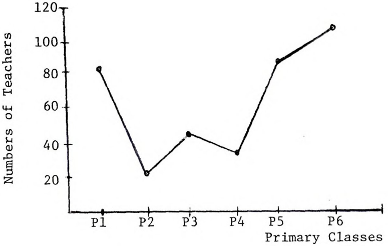

Figure 5. Distribution of teachers by classes they are presently teaching

Figure 5 shows the distribution of teachers by the classes they are presently teaching. A majority of teachers, 83 percent, had taught more than three different classes in their teaching career. The trend in the data of higher number of upper class teachers continued when teachers were categorized into lower (P1 to P3) and upper (P4 to P6) levels. One explanation of this trend may be due to the questionable practice by which the untrained teachers are usually put in the lower classes, and since this study is concerned with the trained Grade II and Grade III, they are probably found in general at the upper level. Nonetheless, the data indicate a distribution of 60 percent and 40 percent respectively for upper and lower levels teachers in this study.

Another characteristic examined had to do with teacher qualification. The study sample included 90 percent Grade II and 10 percent Grade III. This is an indication that fewer

Grade III teachers are left in the school system. This trend was confirmed in the total population of primary teachers in the state by a recent governmental digest of statistics referred to earlier in this writing. However, the number of untrained teachers seems to be on the rise as shown by the data. There is a fair distribution of male and female teachers in the sample, 58 percent and 42 percent respectively. The views expressed by this natural categorization of teachers are significant in particular because of the growing tendency of women teachers remaining longer in the state's primary schools than the men teachers. In addition, the brunt of the problems of mathematics teaching in the primary schools will have to be shared by both male and female teachers.

A consideration of teachers' family involvement is essential to the design of any inservice program, in particular if the program is a long-sustaining one that may demand some out-of-school hours from the teachers. Because of this, teachers were asked to indicate their marital status in the present survey. Ninety-two percent of teachers are married. This is not surprising as it is in keeping with social and cultural setting of the society. However, inservice program design should consider such teacher characteristics related to family and domestic responsibilities which may be a source of obstacle for attendance at inservice programs.

TEACHER PAST PARTICIPATION IN MATHEMATICS INSERVICE TRAINING PROGRAMS

A major aim of the survey in this study is to find out to what extent teachers participated in inservice or refresher course in mathematics. An analysis of teachers' response to the relevant section of the questionnaire was carried out.[121] Participation in previous courses, organizers, main topics dealt with and the effect of this participation on arithmetic teaching are discussed. Non-participants are discussed in terms of awareness of any program in mathematics inservice, willingness to attend future courses, and conditions under which they would participate. In analyzing the responses in this section, major issues are raised and the analyzed data provide some answers.

How Much Have Teachers Participated?

As Tables 3 and 4 show, teacher participation in previous mathematics inservice is very low. Of the whole group of teachers, only 58 teachers or 15 percent have had any previous participation. A breakdown of data in Table 3 shows that urban teachers had attended programs more than the rural teachers. The percentage of attenders by teachers' qualification is low. Although the percentage of attenders among Grade III teachers appears higher than that of Grade II teachers, when the group of 58 attenders was examined, 48 or 83 percent of them were Grade II teachers.

[121] See questions 5 to 7 of Section 1 in Primary Teachers' Questionnaire, p.224.

TABLE 3
Percentage of Teachers Who Had Attended or Not Attended Any Previous Inservice Mathematics Program by School Location

	Urban		Rural		
	No.	Pct.	No.	Pct.	Total
Attenders	55	17.4	3	4.8	58
Non-Attenders	261	82.6	60	95.2	321

No response: 1

TABLE 4
Percentage of Teachers Who Had Attended or Not Attended Any Previous Inservice Mathematics Program by Teacher Qualification

	Grade II		Grade III		
	No.	Pct.	No.	Pct.	Total
Attenders	48	14.1	10	26.3	58
Non-Attenders	293	85.9	28	73.7	321

No response: 1

A further examination of data revealed that some of the Grade II teachers had indicated their two-year retraining program from Grade III to Grade II status as attendance at an inservice mathematics program. In effect, the acutal participation of total group of teachers in a mathematics inservice training is lower than the indicated 15 percent. This finding reaffirms the great need for inservice training elaborated upon in Chapter II.

Who Organized the Courses Attended by Teachers?

The teachers reported organizing bodies for the courses they attended and indicated the duration of the courses.

Figure 6 summarizes the distribution of courses among organizers. Any government program ranging from a one-hour lecture by the School Inspector to the two-year retraining program for Grade III teachers have been classified as those organized by the government. Local school board short courses were also regarded as governmental programs. Programs organized by universities include those of the two Institutes of Education at Ife and Ibadan. Other organizing bodies identified by teachers included: the British Council Officer, publishers such as Oxford Press, Ilesanmi Publishing Company and Onibonoje Company. There was no report of any course organized by a professional teacher organization.

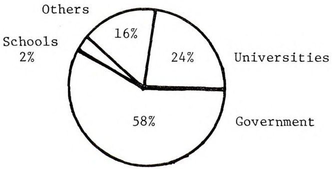

Figure 6. Organizers of courses attended by teachers by percentage distribution of total courses attended

About 39 percent of courses lasted from about two hours to three days. Thirty-five percent of courses were the two-year courses, while the duration of the remaining 26 percent of courses was from one week to four weeks. Strictly speaking, the two-year course is not within the consideration of this study, but it was indicated by teachers since it was also a

form of inservice program for them. The course, however, covered the arithmetic course of the Grade II colleges discussed earlier. On the whole, it can be said that the duration of most courses is about one to three days and only about 15 percent of total courses offered lasted for three or four weeks, while 11 percent lasted for one or two weeks. Very few courses had been held in the school environment. A closer look at data shows five short lectures on metric system in five different schools.

What Main Mathematics Topics Were Covered in the Courses?

Teachers were asked to list the main mathematics topics in the courses they attended. Among the most frequently listed topics are: number, set, the basic operations, fractions and factors. A few teachers listed metric system and "method of teaching lower classes."

Conspicuously absent from teachers' lists are topics dealing with shapes, problem-solving and applications of mathematics, which are important and functional mathematical topics. The topics related to the metric system and "method of teaching lower classes," indicate the awareness of two of the problems currently confronting the primary schools. Nigeria is in a transitional period of changing from the imperial units of measurement to the metric units. However, there is no systematic plan for the modification of classroom instruction at the primary level to meet the needs of this change. It is encouraging that some short courses - though rather too short to be

effective - were organized for some teachers on metric system. Traditionally, the Grade III colleges taught "infant methods." However, with the closure of the Grade III colleges, this area of school methods of teaching had been neglected. The Grade II colleges did not turn attention to this problem soon enough and as a result, it became an area of teacher training which many Grade II teachers are deficient in and, therefore, the need for re-orientation in infant methods.

What Were the Effects of Courses on Classroom Teaching?

One way by which the impact of the courses attended by the teachers on their classroom teaching was investigated was by asking teachers to list the topics that have influenced their teaching and how they did. Of the 55 teachers that had listed topics earlier, only 47 responded to this question. Topics on metric system, numbers and operations were most frequently listed as those that have helped classroom teaching. The other topics listed included sets, fractions, least common multiple and highest common factors. It is significant that about 28 percent of those who responded actually wrote: "none," implying that the topics of the refresher course had not changed their teaching.

Responses to the question of how the topics have changed teachers' lessons varied from change in teaching approach, greater knowledge of mathematics content to observed change in the children. Some of the responses are presented below:

1. The experience I had during my inservice course helped me to approach some topics in a practical way.

2. The children have more understanding of the topic when done practically.

3. They led us to field work.

Lastly, a teacher who participated in a 45-minute workshop on metric system wrote: "Pupils seem to understand this system better than the former ones and I as a class teacher find it easier to teach my pupils."

Respondents were asked to indicate how the courses they attended could have been improved by their organizers. An analysis of the responses to this open-ended question points out some major weaknesses in the present inservice approach to teaching by the inservice instructors and the lack of teaching aids for such programs. Other comments included the need for content improvement, organization of better evaluation process of the inservice programs, the need to make the duration of courses longer and to spread the programs out to more teachers, not only those in the state capital, and the need for a follow-up. Some of the teachers' specific comments point directly to needed improvement that any future inservice plan should consider. Among the specific comments are the following:

1. They could improve the program by conducting more of it to improve teacher's skill in the subject.

2. Those who taught the program could have improved upon it if there had been regular seminars and sufficient teaching aids.

3. They could plead to the government to provide the necessary books and materials needed for the teaching of mathematics.

That there is an interest in and desire for inservice mathematics programs are clearly portrayed in the responses of these teachers. The teachers seemed aware of the need for a long-sustained program to help them in developing the needed skills for mathematics teaching. It appears that both short and long courses will achieve some success if well-planned, though long courses will achieve more and most likely will be more effective.

The Non-Attenders

In an attempt to further assess the impact of the existing programs on all teachers in the sample, the non-attenders gave responses to a few questions related to the organization of inservice mathematics programs. The respondents were asked to indicate if they had heard of any inservice programs even though they had not participated. About 75 percent of 315 non-attenders were not aware of any inservice mathematics programs for primary teachers. Some teachers who had heard about some programs did not know the organizing body. Among the organizers identified by non-attenders were the government, the universities and the British Council, in that order. The response here was very consistent with that of the teachers who had attended former programs. Again, these teachers had never heard of any program initiated by a professional organization or a school. The identified locations included university

campuses, teacher training colleges and the British Council building. In identifying locations, some teachers named the towns. The trend in this identification shows that the big towns of Ibadan, Abeokuta and Ondo were frequently named as locations where inservice training programs had taken place.

The evidence so far indicates that teachers who have had some type of participation in inservice programs seem to appreciate the need for such programs and would like to see them improved and intensified. However, this fact cannot be assumed for those teachers who have had no participation. Therefore, the non-attenders were also asked to indicate their willingness to attend mathematics inservice programs, the significance of such programs to them and the conditions under which they would like to attend.

A majority of the non-attenders, 95 percent or 79 percent of total sample of teachers, indicated willingness to attend mathematics inservice programs. About 85 percent of these teachers indicated their belief that such programs would upgrade their mathematical knowledge and improve their teaching ability. Other items of mathematics inservice training importance that were commonly cited include: "better position to help children for nation building," "mathematics is useful in everyday life," "it will promote the falling standard of mathematics teaching in the schools," and "it will help teachers to teach better."

The conditions under which non-attenders would participate were first considered in general, and specific conditions were

later investigated under four main categories. The categories are: (1) conditions related to time and place, (2) cost of in-service training to teachers, (3) availability of reward, and (4) others. Many teachers indicated "any condition" and some would like a full-time one-year course for such retraining programs. A trend in the data showed that teachers with many years of teaching experience (25 to 33 years) indicated they wanted, "just a short refresher course." However, about 36 percent of the non-attenders would participate if time and place were made convenient. Teachers' convenience as coded from the responses means during the long (summer) vacation and in "nearby town." Other convenient locations mentioned by teachers included "a school in town" and "the divisional head-quarter;" and for time, evening, after school hours, and during school hours were all frequently indicated as convenient times.

Only 32 percent of these teachers indicated desire for attendance if it was at no cost to them -- that is, if free lodge, board and cost of transportation to inservice location were provided. Similarly, only a small proportion of these non-attenders, 25 percent, indicated the availability of a reward as a condition for attendance. The types of reward asked for by those who did included: recognized certificate, encouragement from the Ministry of Education and promotion. A variety of conditions were classified under the heading "others." The number of respondents for each of these

conditions ranged from one to 25. When summarized, they were grouped as follows:

1. Teaching Aids: some teachers would attend under the condition that inservice programs would help them in producing some teaching aids which they could later use in their classes and in helping them to use some teaching aids appropriately.

2. Organization: some respondents mentioned they would like "experts" to handle the courses, and would be willing to pay a little fee. Others indicated that the course should be non-residential and that participants should be grouped by ability.

3. Content: some respondents indicated willingness to participate under the condition that they could teach the new topics in their classes, and that the course content would be helpful to them.

The responses of the non-attenders have been elaborated upon not only because they form a majority or 83 percent of total sample of teachers, but also because the issues involved are relevant to the successful organization of inservice programs. Although the views and preferences of the total group of teachers in the study are considered later in this analysis, the responses of the non-participants raise some problems of arithmetic teaching that merit discussion at this point.

The crippling effect of the lack of teaching aids is again seen in the conditions for attendance stipulated by some teachers. If classroom teaching should be enriched by an increase in the use of teaching aids, then retraining programs for teachers should help them in this direction as well as in other areas of needs. Evidence that justifies such an objective of inservice training had been provided earlier as in the case of the different workshops in the United States and the British teachers' centers, for example.

The issue as to whether the teacher could teach the topics learned in inservice program seems to suggest a problem related to the administrative control of school syllabus and secondly to the lack of basic mathematics understanding of teachers.

On the administrative level, the syllabus provided for arithmetic teaching is still the 1954 syllabus mentioned earlier, and arithmetic examination in the First School Leaving Certificate examination is still based on this syllabus. In effect, topics that are not explicitly stated in this syllabus appear to some teachers as topics they cannot teach in their classes. For example, if an inservice training program covers the concept of set, as it has been indicated in some of the previous programs, and if the program does not relate this topic to the many number topics and other topics taught in the primary classes and included in the present syllabus, some teachers would regard the concept as "new" and outside the syllabus. They, therefore, believe that it cannot be taught in their classes. Clearly, one other complex factor contributing to this type of confusion, in addition to the administrative control of the syllabus, is found the the low level of mathematical background and understanding of the teachers themselves.

The concern of teachers in keeping rigidly to the content of the syllabus is probably with some justification. The investigator had been part of a short course in which teachers had complained of their inability to introduce some of the new ideas for fear they might be reprimanded by the school inspector for teaching a topic that was not stated in the scheme of

work. The validity of such a statement cannot be assumed, but it calls for further probing and modification if inservice work should serve its purpose.

A more valid and more crippling problem of administrative rigidity in connection with mathematics curriculum of the primary school that is not conducive to the organization of effective inservice mathematics programs is in the well-known plight of the "early innovators" of curriculum change in this discipline. As a result of the work of the African Mathematics Program in the 1960's, mentioned in Chapter II, a few headmasters of primary schools initiated and followed through a program in the "new" mathematics or the Entebbe Mathematics Program in their schools. At the end of the program, these school heads petitioned the State Ministry of Education to provide examination related to the new program for their pupils as an alternative to the Arithmetic Examination of the First School Leaving Examination.[122] The petition was denied and the schools affected made great effort to cover missing grounds, if any, before the children sat for the same arithmetic examination as all other children sitting for the examination in the state. It was reported by headmasters that the children in this "converted" program performed better in the arithmetic examination than children in the regular arithmetic program.

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[122] Much of this information is well-known in the State. However, specific information was also gathered during school year 1972-73 in an informal interview with three headmasters of primary schools.

The headmasters believed that their gain in performance was due to the "new" mathematics approach used with the children. Consequently, a pattern of three or four years of "new" mathematics, followed by three or two years on the approved Arithmetic Syllabus with concentration on the examination requirement has developed in a few primary schools of the state.

The effect of a development of this nature on teacher retraining is negative, since some teachers could look on it as a disapproval of the government towards the introduction of mathematics teaching in the primary schools. Yet, the development of the more recent years has also shown that Western State government is acutally planning to introduce mathematics teaching in all the primary schools. There seems to be enough evidence pointing to the fact that one major reason why the new mathematics curriculum is still being shelved is the lack of adequately trained teachers in the primary schools. One way of solving this problem is in the initiation of a systematic inservice program for primary school teachers.

In summary, the findings of this section seem to suggest that some attempts are being made to re-educate teachers for the teaching of mathematics in the primary schools. The attempts, however, are too short, too haphazard, and they reach only a handful of teachers. The findings further suggest that motivation for inservice can be both intrinsic and extrinsic; that teachers are willing and ready to participate in inservice mathematics programs; that a local arrangement would be more

convenient for teachers; and that teachers and administrators should be part of these programs in order that the goals and objectives might be shared in common. Furthermore, there is a suggestion for a more clearly stated and modified governmental policy on mathematics teaching in the primary schools than what now exists, so that creative practices might be encouraged through inservice training and translated into better teaching in the primary schools. Lastly, findings suggest that there is a grave need for the supply of teaching aids needed for mathematics instruction.

TEACHER ATTITUDE TOWARD MATHEMATICS AND CLASSROOM PRACTICES

The fifth major area of this analysis deals with the issue of teacher attitude and classroom practices related to mathematics teaching. That favorable attitudes towards mathematics maximize the possibility of learning and teaching being effective has been expounded by many authors, among them was Neale.[123] Although the survey was not intended to give final answers on attitudes or instructional practices, yet this section was designed to probe into teachers' practices so that information gathered from such probing might further suggest directions for the design of inservice programs. There are four parts in this section. They are: (1) teachers' ranking of arithmetic teaching, (2) teachers' attitude towards

[123] D.C. Neale, "The Role of Attitude in Learning Mathematics," The Arithmetic Teacher, Vol. 16, No. 11, 1969, pp. 631-640.

mathematics activities, (3) the materials of instruction and (4) teachers' classroom practices.

Rank of Arithmetic Teaching

A rank-ordered scale consisting of the nine main subjects of the Western State primary school curriculum was developed.[124] Teachers were to rate each subject in order of the subject they liked best to teach. The data were analyzed in two ways. First, an examination of the exact rank accorded arithmetic teaching by each of the total group of teachers was examined. Secondly, the ranking was dichotomized into three categories, namely: first to third positions, fourth to sixth positions, and seventh to ninth positions. A test of differences between the following groups was carried out: urban and rural teachers; male and female teachers; and lower and upper level teachers.[125]

Findings:-As shown in Figure 7, 36 percent of teachers ranked arithmetic as the subject they liked best to teach, 24 percent ranked it second. The percentage of teachers who chose subsequent positions decreased, except for the rise to five percent of teachers who ranked arithmetic in the ninth position.

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[124] See Primary Teachers' Questionnaire, Section II, p. 225.

[125] The .01 level of significance for the rejection of statistical hypothesis being investigated was selected for these and subsequent tests in the study. That is, all differences between reported categories of responses mentioned in the study are statistically significant to the one percent level of confidence.

Scale: 1mm to 1 percent

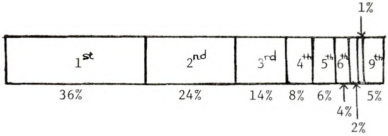

Figure 7. The exact ranking of arithmetic as a teaching subject by all teachers

It was expected that there would be differences in the ranking of arithmetic as a teaching subject between urban and rural teachers; male and female teachers; and lower and upper primary level teachers respectively. An examination of Table 5 indicates that teachers' responses were generally the same. To confirm this trend, a chi-square analysis of the data in each category was carried out. There was no significant difference in each case ($p < .01$).

<u>Discussion</u>:-It appears that most teachers in the study generally rated arithmetic teaching high in their choice of teaching subjects. In interpreting these data, however, attention should be paid to the fact that there might be a possibility of Hawthorne Effect -- that is, teachers putting their priority on arithmetic teaching because they were aware of participating in a study involving the teaching of arithmetic. Secondly, the study of Goodlad and Associates (1970) mentioned

earlier suggests that some of the teachers might in fact not be teaching arithmetic best of all the subjects, even though they believe they do. In general terms, however, the findings suggest that there is a favorable atmosphere for the motivation needed for an inservice program.

TABLE 5
Rank of Arithmetic as a Choice Subject by Teachers in Categories

	(Rank 1 to 3) No.	(Rank 1 to 3) Pct.	(Rank 4 to 6) No.	(Rank 4 to 6) Pct.	(Rank 7 to 9) No.	(Rank 7 to 9) Pct.
Teachers by Locations						
Urban.	234	76.7	53	17.4	18	5.9
Rural.	49	77.8	12	19.0	2	3.2
Teachers by Sex						
Male	164	77.0	37	17.4	12	5.6
Female	119	76.8	28	18.1	8	5.1
Teachers by Class Level						
Lower.	116	80.6	25	17.4	3	2.0
Upper.	165	74.7	39	17.6	17	7.7

No response: 3.1 percent to 3.9 percent

Teachers' Attitude Towards Mathematics Activities

The eight forced-choice items found in Section IIB of the Primary Teachers' Questionnaire were used to measure teachers' attitude towards mathematics activities. This scale was adapted by the investigator for use in the present study from the Teacher Mathematics Attitude Test[126] which was based on the

[126]The Teacher Mathematics Attitude Test was used in an Evaluation Program of Mathematics Teaching in the Elementary School in California. Cited in: Larsen, E.P. (director) The Mathematics Improvement Program (A Study of Educational Effectiveness with Planned Program Variation), Oakland: Oakland Unified School District, 1970, pp. 135-136.

arithmetic-interest items of Kuder Inventory of Occupational Interests. The teacher was asked to choose one of two activities. His choice showed whether he preferred mathematical activities or non-mathematical activities. A teacher's total score indicated whether his interests were similar or dissimilar to the interests of those engaged in occupations involving arithmetic or mathematics teaching. For the purpose of this analysis, a scale score of one was considered positive for a mathematical activity, and zero considered negative for a non-mathematical activity.

<u>Findings and Discussion</u>:-Thirty-one percent of teachers scored eight points each on the scale, while each of four teachers scored zero on the total scale score. The average score of teachers was 5.8 with a standard deviation of 2.1. These scores suggest that 68 percent of teachers scored between 3.7 to 7.9 on the attitude scale. However, when the paired items were considered separately, the reaction of teachers to each item was better appraised. Table 6 shows the percentage of teachers' positive and negative responses to each item. Whereas the choice between watering maize and solving arithmetic problems was quite distinct, it was a close choice between being a secretary or being treasurer.

TABLE 6
Percentage of Teachers' Responses on
Mathematical and Non-Mathematical Activities

Mathematics Interest Item	Percentage of Positive Response	Percentage of Negative Response
a. Help a child with his spelling lesson. b. Help a child with his arithmetic problem.	78.5	21.5
a. Collect figures of what is happening in trade and industry. b. Weave cloth on a hand loom.	76.6	23.4
a. Do typing and shorthand. b. Do work that requires mental arithmetic.	82.9	17.1
a. Study methods of supplying maize with water. b. Study rapid methods of solving arithmetic problems.	86.4	13.6
a. Take a course in mathematics. b. Take a course in English language.	63.8	36.2
a. Be the treasurer of your local club. b. Be the secretary of your local club.	53.7	46.3
a. Make tables of figures on the costs of food and clothes. b. Write compositions on your favourite games.	62.5	37.5
a. Estimate the cost of equipment for your school. b. Decorate the school hall for a play.	74.2	25.8

No response in 1 percent of cases on each item.

A third dimension of the analysis at this point was a determination of whether or not there was any difference in attitude of teachers who had previously attended any refresher course in mathematics and those who did not. A chi-square analysis of differences in the frequency of occurrence of positive

and negative reactions on the eight forced-choice items among attenders and non-attenders did not yield any significant difference. Table 7 shows a breakdown of positive and negative responses on two of the eight items of the mathematics interest scale. The two items chosen were those with the highest and lowest positive responses respectively when the total group of teachers was considered.

TABLE 7
Responses of Attenders and Non-Attenders
on Two Mathematics Interest Items

Mathematics Interest Item	Attenders		Non-Attenders	
	Positive	Negative	Positive	Negative
Study methods of supplying maize with water/Study rapid method of solving arithmetic problem.	48 (83%)	10 (17%)	277 (87%)	41 (13%)
Be the treasurer of your club/ Be the secretary of your club.	34 (59%)	24 (47%)	168 (53%)	150 (47%)

No response in 1 percent of cases on each item.

The general findings here also suggest that teachers have a positive inclination towards mathematics activities. It is interesting to note the high positive percentage of responses in the two instances where teachers had to choose between a mathematics activity and a farming activity and also between a mathematics activity and being a typist. These high ratings of mathematics activities in these cases might in fact be due partly to some unfavorable social values attached to being a farmer or being a typist. Nevertheless, the reactions on the

whole provide a favorable stage for a mathematics retraining program.

The Materials of Instruction

In order to access the availability and use of materials of instruction, teachers were asked to list both the pupils' and the teachers' books used for the teaching of arithmetic. In addition, they were to list the teaching aids they use in the teaching of arithmetic.

Pupils' books were categorized into three groups, namely: Modern, Transitional and Traditional, for the purpose of analysis.[127] The teachers' use of reference books was investigated by a consideration of whether a teacher used no reference book at all, whether he used the pupils' textbooks or an advanced book as his reference book. Lastly, the teaching aids were considered as to whether they were manipulative or non-manipulative.

Findings and Discussion:-Most pupils' books indicated by the majority of teachers (58% of teachers) were traditional books. Their content is still mainly the arithmetic that was taught three or four decades ago. They contain different types of how-to-do-it introductions to topics, and step-by-step solutions to problems. Consequently, problem-solving becomes mere exercise and stereotyped routine procedures

[127]This classification is based on the investigator's knowledge of the content of the books listed.

characterize arithmetic lessons. Table 8 shows a summary of the pupils' books listed by teachers.[128] As suggested by some of the titles, some of the books encourage routine learning and rote memorization. Forty percent of teachers cited books classified as transitional. These are new editions of the traditional books which had been metricated to meet the current change in the society.

TABLE 8
Summary of Pupils' Books Used for Arithmetic Teaching by Categories

Modern Textbooks

New Primary Mathematics for Nigeria
Oxford Modern Mathematics
Entebbe Mathematics Series
Preparatory Modern Mathematics
Onibonoje Modern Mathematics
Progressive Arithmetic
Modern Primary Mathematics
Ilesanmi Modern Mathematics

Transitional Textbooks

Oxford Arithmetic (metricated edition)
Larcombes Primary Arithmetic (metric and decimal edition)

Traditional Textbooks

Larcombes Primary Arithmetic (middle and upper standard)
Scholarship Speed Sums and Mathematics
Revision Arithmetic for Common Entrance Examination
Ways to Success -- Step 1
Scholarship Arithmetic Tutor
Speed and Accuracy Test
New Nation Arithmetic

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[128] Authors' names are left out for reasons of anonymity, although some titles still reflect the publishers. Besides, not all books were named by authors.

Although only eight percent of teachers indicated textbooks classified as modern textbooks, the indicated variety is encouraging. The Western State of Nigeria, as well as the other states, seem to be witnessing currently an upsurge of the activities of indigenous Nigerian textbook writers. This upsurge is well reflected in the production of primary school textbooks, including mathematics textbooks. The quality and effectiveness of most of the books still have to be evaluated before their impact on primary mathematics teaching can be fully assessed. In addition, teachers still have to learn the mathematics content of some of the books before they can be effectively used for the teaching of mathematics in the primary schools.

A second approach employed in the analysis of data on pupils' textbooks was to investigate whether teachers at the lower or upper level differed in their use of the different categories of pupils' textbooks. It was expected that, since new books for primary mathematics are beginning to increase in the book market, and since these books are written in series beginning with primary one, two, and so on, lower primary classes might be using more of the modern books than the upper primary classes. A chi-square analysis of the data indicates that the difference in the use of modern textbooks is significant beyond the .01 level in the direction of lower primary teachers. Table 9 summarizes the data.

TABLE 9
Relating Teachers' Class Levels to the Categories of Pupils' Textbooks

Class Levels	Modern		Transitional		Traditional	
	No.	Pct.	No.	Pct.	No.	Pct.
Lower Level	22	14.6	55	36.7	73	48.7
Upper Level	10	4.5	91	50.0	121	54.5

No response: 8
X^2 = 11.8, significant at .01 level

The teachers' reference books vary slightly in content from the pupils' textbooks. The findings show that most teachers (56 percent) used the pupils' textbooks and/or the teachers' guides, where such guides existed, as their reference books. Forty-two percent of the teachers used books with more advanced content than the pupils' books, while two percent of teachers indicated they did not use any reference book. Figure 8 shows a distribution of the categories of teachers by years of teaching experience and the type of reference books they use for arithmetic teaching.

It is important to note that as many as 56 teachers (about 15 percent) of the total group of 380 teachers did not respond to this question. The suggestion of the investigator is that either these teachers do not see the need for a reference book in arithmetic teaching or they teach from the pupils' books. Suitable reference books for arithmetic teaching seem to be scarce in the society's book market, and unlike the pupils' textbooks, book writers seem not to have turned attention to this need yet. This scarcity is reflected in the types

TABLE 9
Relating Teachers' Class Levels to the
Categories of Pupils' Textbooks

Class Levels	Modern		Transitional		Traditional	
	No.	Pct.	No.	Pct.	No.	Pct.
Lower Level	22	14.6	55	36.7	73	48.7
Upper Level	10	4.5	91	50.0	121	54.5

No response: 8
$X^2 = 11.8$, significant at .01 level

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of books teachers listed. Some of the books are those traditional textbooks that had been rejected in the secondary schools to give way to modern mathematics teaching at that level. There are, however, a few contemporary books such as Ilesanmi Modern Mathematics Teachers' Note, Entebbe Mathematics Series and The Teaching of Arithmetic in Primary Schools, listed by teachers. On the other extreme are some outdated books such as A Shilling Arithmetic Book and Durell Arithmetic Book still being used as reference books by primary school teachers.

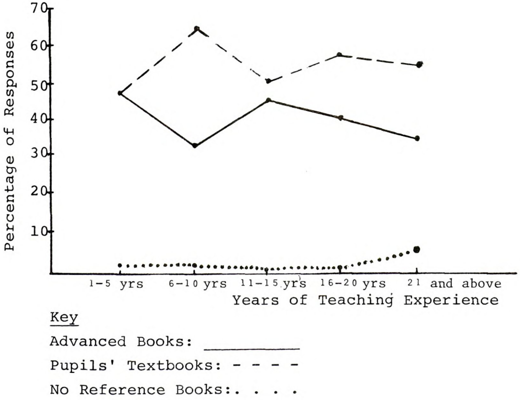

Figure 8. The categories of teachers by years of teaching experience and the type of reference books they use

The findings on the teachers' teaching aids from the responses given by teachers support the same gloomy picture presented by the headmasters' responses which were discussed earlier. Most teaching aids used in arithmetic teaching are non-manipulative. Only about 35 percent of teachers reported teaching aids that could be classified as manipulative. Among these were seeds and stones for counting, counting sticks, card-board clock-face, and spinning tops for sums. Many teachers indicated as their teaching aids: blackboard sketches, drawing board and chalk. Most of the teachers' aids involved children's participation in a passive way rather than an active way. In the case of teaching aids used by teachers, as in the case of their reference books, 52 teachers gave no response to this question.

In general, the findings further suggest the great scarcity of teaching aids for mathematics teaching. Yet, if a primary mathematics class should be a place of inquiry and activity, where children learn mathematics rather than absorb ideas passively, then adequate provision should be made for appropriate teaching aids. Furthermore, the provision of teaching aids is only a means to an end, teachers would need to use the aids or learn to use them appropriately for effective teaching. Some of these teaching aids can and should be developed from materials in the child's surrounding. However, such adaptations must be skillfully done in order not to present wrong models and faulty concepts. Inservice training

programs can be a forum for the creation of such locally produced teaching aids.

There is a definite need, however, for commercially produced teaching aids for the Western State primary schools. Hugh Hawes made the case for teaching aids needed for the country's primary education when he wrote on Nigeria's plan for universal primary education:[129]

> The new teachers entering the schools for UPE are going to need support of two main kinds. First, it will be essential that they have professional guidance and supervision; and secondly, they will require adequate material support... It will further entail at least one major decision: whether some or all of the materials are to be mass produced by the government (and if so, where and how?) or whether commercial publishers are to be in partnership with the government.

The findings here suggest that material support is needed for quality teaching of all school subjects including mathematics.

Teachers' Classroom Practices

The analyses in this section so far have focused on teachers' attitude towards mathematics activities and their instructional materials. But teachers' daily classroom practices are also reflections of their attitudes toward teaching. Therefore, a scale of ten statements related to mathematics teaching was developed to provide some measures of teacher classroom practices. The statements are found in Section IVB of the Primary Teachers' Questionnaire. There are five

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[129] Hugh Hawes, "UPE in Nigeria, 3: Logistics," West Africa, October 7, 1974, p. 1213.

positive statements and five negative statements. Each item in the scale had Lickert-type response alternatives ranging on a five-point scale from "completely agree" to "completely disagree."

The dimensions and items covered in the scale are some of the characteristics generally related to mathematics teaching. They include issues related to individualization, planning for instruction, group work, discovery approach, application and evaluation. There was no definite expectation for the reactions of teachers, the main purpose of the scale was to probe their practices in order to determine the experiences which inservice training should establish, reinforce or enrich. Table 10 shows the distribution in percentage count of teachers' responses on the five-point scale.

Teachers seemed to have agreed with positive statements and disagreed with negative ones in general. However, the data show a special problem in the case of children being too young to discover their own rules. It appears that there is the need to help teachers whether at the lower or upper level in the use of the discovery approach, so that all children can discover their own rules in the classes. Approximately 20 percent of teachers assigned homework for misbehavior, another 18 percent agreed they could teach arithmetic without the use of teachers' guides or a method book; and still another 18 percent agreed that arithmetic has little practical application in Nigerian life. If arithmetic teaching should

emphasize application and help pupils enjoy the subject, the type of reactions expressed by these 18 to 20 percent of teachers, as suggested by these findings, need to be discouraged. The experiences provided in an inservice program for teachers could incorporate activities that could help teachers in establishing more favorable practices.

TABLE 10
Percentage of Teachers' Responses to
Statements on Classroom Practices

Statements	CA	A	U	D	CD
It is necessary to give individual help to pupils in arithmetic lessons.	70.2	25.3	1.8	1.3	1.4
Pupils learn from one another so I encourage group work in my arithmetic class.	39.6	42.8	4.5	8.7	4.4
Working with arithmetic games and puzzles in the classroom can be a worthwhile activity.	39.9	50.5	5.1	3.4	1.1
A field trip to the market place is a valuable resource for arithmetic teaching and learning.	32.2	47.6	10.3	5.1	4.8
Teachers should change their approach to classroom teaching to make use of some of the newer techniques and teaching ideas.	50.3	39.7	6.1	2.7	1.2
I can teach arithmetic without reading teachers' guides and method books.	6.1	11.4	5.6	41.5	35.4
Arithmetic is a skill with little practical application in Nigerian life.	6.6	11.4	7.7	34.3	40.0
Children in the class I teach are too young to discover their own rules for solving arithmetic problems.	16.5	27.9	11.4	29.3	14.9
I assign extra arithmetic problems as homework when pupils misbehave.	5.8	14.1	7.1	31.2	41.8
One final test at the end of term is enough to find out how well my pupils understand their arithmetic lessons.	4.5	5.6	4.1	28.9	56.9

CA = Completely Agree U = Uncertain CD = Completely Disagree
A = Agree D = Disagree No response: 4 in each item

This section of the analysis discussed the attitude of teachers towards mathematics activities and arithmetic teaching, teachers' materials of instruction, and some of their classroom practices.

VIEWS AND PREFERENCES ON INSERVICE MATHEMATICS PROGRAMS: TEACHERS, HEADMASTERS AND ORGANIZERS

An important part of the survey was concerned with the establishment of teachers', headmasters' and organizers' views and preferences on mathematics inservice training. This section of the data analysis reports the following aspects of the survey: (1) the learning experiences required by teachers in an inservice program, (2) the views of teachers, headmasters and organizers on inservice organizations, (3) their views on inservice program evaluation, and (4) the demand for future inservice mathematics courses.

Inservice Learning Experiences

In order to investigate what learning experiences teachers wanted from inservice programs, data were analyzed from responses of teachers to related questions in the Primary Teachers' Questionnaire.[130] The main data were those from teachers' selection of mathematics topics for inservice program and the list of mathematics topics they found difficult to teach.

A list of mathematical topics was build up from mathematics

[130] See Primary Teachers' Questionnaire, Section I, No. 4; Section IIIA; and Section V, Nos. 9 and 10.

curricula related to primary mathematics teaching in the Western State.[131] The selected topics covered concepts in the areas of number, measurement, geometry and application. The teachers were asked to check "yes" for topics they would like included in an inservice mathematics program according to their needs.

When the group of teachers was considered as a whole for analysis, eight topics were requested by over 80 percent of teachers, another eight topics were requested by 70 to 79 percent of teachers, while the remaining five topics were requested by 55 to 69 percent of teachers. The priority topic selected by teachers seemed to be "metric system" selected by 96 percent of teachers, while the topic "mean, mode and median" was requested least by 57 percent of teachers. Table 11 shows the percentage distribution of selected topics first by all teachers, then by teachers classified into lower and upper levels.

A further analysis showed that there were no differences between the responses of lower level and upper level teachers, except in the selection of the topic "Solid Geometric Figures" where the analysis of data yielded a significant difference. The data indicated that upper primary teachers more than lower primary teachers requested the topic on solid geometry.

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[131] This list was culled from Primary School Mathematics Guidelines suggested by the Nigerian Education Research Council (1971); Teacher Training College Mathematics Program suggested by NERC (1972); and the Basic Mathematics Syllabus for Grade II Teachers Colleges in Nigeria.

TABLE 11
Percentage of Teachers Who Would Like Topics Included in Inservice Programs

	All Teachers	Lower	Upper	No Response
Base 10 numeration system.	75.4	77.0	74.4	13
Four basic operations with whole numbers . .	70.0	72.9	68.1	13
Common and Decimal Fractions	80.9	80.4	81.2	9
Four Basic Operations with Fractions	73.8	75.0	72.9	10
Simple Idea of Set	87.7	89.9	86.2	13
Adding and Subtracting Positive and Negative Numbers.	73.7	79.1	70.1	15
Numeration System with Bases Other than 10, e.g., Base 5	77.9	80.7	76.1	18
Factors, Primes and Composite Numbers. . . .	79.6	77.2	81.2	13
Properties of Points, Lines and Planes . . .	68.0	70.1	66.7	17
Solid Geometric Figures (e.g., Cubes, Cuboids, Pyramids, Prisms, etc.)	79.5	69.8	85.7	10
Idea of Area and Perimeter of Regions. . . .	78.1	77.0	78.9	14
Idea of Symmetry	62.9	63.3	62.7	16
Idea of Congruence	62.1	55.8	66.4	16
Metric System of Measurement	95.7	93.9	96.9	9
Interpreting and Constructing Line, Circle and Bar Graphs	81.5	77.5	84.3	17
Simple Geometric Constructions (e.g., Perpendicular Bisector of a Line, Bisector of an Angle, etc.).	80.1	76.7	82.3	19
Mean, Median and Mode.	57.3	58.1	56.8	24
Making up and Solving Mathematical Sentences.	80.1	84.2	77.4	18
Solving Mathematical Problems.	86.2	86.9	85.7	17
Mathematical Ideas Used in Trade and Business (e.g., Discount, Interest, Profit and Loss)	83.2	82.5	83.6	12
Simple Idea of Probability	62.8	63.5	62.3	20

In all cases, more than 50 percent of teachers requested all the topics. A suggestion from the findings is that these topics should form the needed guide for topics to be included in mathematics inservice training. Only 24 of the 380 teachers indicated additional topics in the section provided for these. All the additional topics indicated were subsets of the major topics already requested. For example, eleven teachers indicated "metric system-conversion" as their additional topic even when they had already checked the topic "metric system."

Another source of mathematical topics suggested for inclusion in the inservice program was the response of teachers to the question: List the topics in arithmetic you found most difficult to teach. The topics listed by teachers were classified for analysis under the headings: numeration and notation; operation on whole numbers; fractions and decimals; operations with fractions; measurement, including metric system; simple business arithmetic, including simple and compound interests; and geometry. The two most difficult topics listed by many teachers were metric system and fractions. These two topics were also rated as highly needed as the earlier data had shown.

When the data were further analyzed, some other problems that an inservice program can help teachers with were found. These problems include those of topic placement at a particular class level and those dealing with the application of

mathematical concepts to other areas of learning. As an example, a Primary 2 teacher listed "long-division" as a difficult teaching topic in his class. It is most unlikely that many Primary 2 children, most of them seven years old, have the readiness and the prerequisites for long-division. Other problem areas indicated with a high frequency by teachers were those related to "addition with carrying" and "subtraction with changing." The data here suggested the need to help teachers, especially lower primary teachers, with these basic but important arithmetical concepts.

In addition to the mathematical topics for inservice program, teachers were asked to rate a set of inservice learning experiences in order of their greatest needs. The chosen priority by teachers was "learning the subject matter of mathematics covered in the syllabus." Table 12 shows other inservice experiences rated by teachers in order of priority. The learning experiences were rated by an indication of 1 for the first priority, 2 for the next and so on. The data were analyzed by taking the average index for each learning experience, hence the statement with the least average has the highest priority.

It might be suggested from the data that teachers' first priority is a combination of learning the subject matter of mathematics and learning about child development. It could be argued that the six topics offered for priority selection did not necessarily include one or more suggestions that

teachers might have suggested for inclusion in future training program. The teachers were, however, given a chance to add any new topics that might be uppermost in their minds. There were no additional topics or comments on inservice learning experiences requested by the teachers.

TABLE 12
Choice of Inservice Learning Experiences
by Teachers in Order of Priority

	Mean	S.D.
Learning the subject matter of mathematics covered in the school syllabus	2.52	1.6
Study of child development, learning problems of pupils and methods of dealing with them	2.57	1.5
Teaching methods, aids and materials	3.09	1.2
Planning and Preparing Lessons	3.12	1.3
Method of dealing with large classes including pupils with varying abilities	4.41	1.4
Setting, marking and interpreting teacher-made tests and school examinations	5.58	1.2

On the whole, the data seem to suggest that the teachers would want an inservice mathematics training program to include not only the subject matter of mathematics, but other learning experiences which include the study of child development, teaching methods, aids and materials. It might further be suggested that teachers would like to have learning experiences in the other areas such as planning and preparing lessons, setting and making examinations, and how to organize learning environment.

Organization of Inservice Programs

This sub-section of the data analysis deals with responses of teachers, headmasters and organizers on organizational aspects of the inservice training programs.[132] The issues investigated include the following: (1) mathematical content scope and method, (2) location, duration and time, (3) related administrative questions, (4) inservice instructors, and (5) factors that affect attendance at inservice programs.

Mathematical Content and Method:-Each group of respondents was asked to respond the question, "What mathematical content should be included in the program?" Three alternatives were given with space provided for respondents to name other alternatives. The analyzed responses are presented in Table 13. The content of the primary school mathematics syllabus appears to be the unanimous choice of teachers, headmasters, and an organizer.

In response to the question dealing with method of approach for inservice mathematics program, a majority of the respondents indicated that the program should deal with the subject matter, methods and materials of instruction. A total of 75 percent of teachers, 83 percent of headmasters and 100 percent of the organizers who responded suggested this

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[132] Responses analyzed here were those made to the questions found in (1) Primary Teachers' Questionnaire, Section V; (2) Headmasters' Questionnaire, Section II; and (3) Organizers' and Sponsors' Questionnaire, Section II.

approach. Only seven teachers felt that inservice mathematics program should deal exclusively with the subject matter of mathematics.

TABLE 13
Number and Percentage of Responses in Regard to Mathematical Content of Inservice Programs

	Teachers		Headmasters		Organizers	
	No.	Pct.	No.	Pct.	No.	Pct.
Content of the primary school mathematics syllabus.	186	49.2	42	52.5	1	100
Content that goes beyond the primary syllabus.	61	16.1	20	25.0	0	0
Content of both the primary and secondary school mathematics syllabi	130	34.4	18	22.5	0	0
Other (specify)	2	0.3	0	0	0	0
TOTAL.	378	100	80	100	1	100
No response:	2		0		4	

Location, Duration and Time:-The questions of location, duration and timing are curcial to the inservice design. A definite trend in data showed a high percentage of respondents would like locations close to their school or town. Table 14 shows the summary of the responses. A teacher training college near the teachers' town or a secondary school in town was most frequently chosen by teachers and headmasters, about 71 percent of each group. An organizer, 33 teachers and six headmasters indicated a primary school in town or the village community center as possible location for inservice training.

TABLE 14
Preference for Inservice Locations

Locations	Teachers No.	Teachers Pct.	Headmasters No.	Headmasters Pct.	Organizers No.	Organizers Pct.
Teacher Training College near Town.	136	35.8	29	36.3	0	0
A Secondary School in Town	133	35.1	28	35.0	0	0
University Institute of Education.	77	20.3	17	21.3	0	0
Others	33	8.8	6	7.4	1	100
TOTAL	379	100	80	100	1	100
No response:	1		0		4	

A further analysis of data, as given in Table 15, showed that there were no differences in the responses of urban and rural teachers. Although an Institute of Education was chosen in the third place by about 20 percent of teachers, it might be suggested that it could be used as an inservice location for teachers in its neighboring schools in addition to its other inservice functions.

TABLE 15
Location Preference of Urban and
Rural Teachers in Percentage

	All Teachers %	Urban Teachers %	Rural Teachers %
Teacher Training College near Town. .	35.8	35.4	38.1
A Secondary School in Town.	35.2	35.1	34.9
University Institute of Education . .	20.3	20.2	20.6
Others.	8.7	9.3	6.4

Preferences for the time and duration for inservice programs were investigated by the question: When should inservice program be conducted? Respondents had four alternatives to choose from and a fifth section for them to add their own alternatives, if any. One alternative was an example of a short concentrated course period, while the other three were long-sustained examples suggesting the use of a radio course or a correspondence course for a follow-up. The distribution of responses among the three groups is indicated in Table 16. The majority of teachers or 39.2 percent, chose to attend the three-week course during the long vacation. About 26 percent of teachers would attend a two-week short courses followed by a correspondence course during the school year.

TABLE 16
Distribution of Responses Concerning Time and Duration of Inservice Training Programs

	Teachers		Headmasters		Organizers	
	No.	Pct.	No.	Pct.	No.	Pct.
Three weeks during the long vacation.	148	39.2	28	35.0	0	0
Two weeks during the long vacation followed by a correspondence course during the school year . .	98	25.9	28	35.0	0	0
Two weeks during the long vacation followed by a radio course during the school hours throughout the school year	73	19.3	15	18.8	0	0
Three-hour sessions fortnightly throughout the school year. . . .	54	14.3	7	8.7	0	0
Other (please state).	5	1.3	2	2.5	1	100
TOTAL.	378	100	80	100	1	100
No response:	2		0		4	

Headmasters were evenly divided on the first two alternatives on timing for inservice program, with 35 percent saying it should last for three weeks during the long vacation and another 35 percent opting for two weeks followed by a correspondence course during the school year. Two other alternatives were suggested under others. Four teachers suggested one and a half hours meeting weekly throughout the school year; and one teacher, two headmasters and one organizer suggested three weeks over the long vacation followed by a correspondence course. A test of difference on data yielded no significant difference in the responses of urban and rural teachers. It is to be noted that three-hour sessions fortnightly throughout the school year was not favorably received as an alternative by many teachers and headmasters.

Related Administrative Questions:-The findings on four administrative issues related to the organization of inservice programs are discussed here. They include: the issue of compulsion, reward for successful inservice attendance, the instructors of inservice courses and the participation of headmasters and inspectors of schools.

The respondents varied on the issue of whether inservice mathematics programs should be made compulsory for all teachers or not. Table 17 shows that nearly 33 percent of teachers, 49 percent of headmasters and 100 percent of the organizers who responded said that inservice should be made compulsory for all teachers.

TABLE 17
Distribution of Responses on Whether Inservice Mathematics Programs Should be Made Compulsory or Not

Statements	Teachers		Headmasters		Organizers	
	No.	Pct.	No.	Pct.	No.	Pct.
Compulsory for all primary school teachers.	124	32.8	39	48.8	1	100
Optional for teachers.	65	17.2	5	6.2	0	0
Compulsory for some teachers, who would become qualified to be special mathematics teachers in the primary school? (They may teach some other subjects as well.)	189	50.0	36	45.0	0	0
Other (explain).	0	0	0	0	0	0
TOTAL	378	100	80	100	1	100
No response:	2		0		4	

On the other hand, 50 percent of teachers and 45 percent of headmasters indicated that the program should be made compulsory for some teachers, who would become qualified to be special mathematics teachers in the primary schools and they might teach other subjects as well. Only 17 percent of teachers and six percent of headmasters felt that the program should be optional to teachers. A suggestion from these findings is that the use of specialist teachers should be investigated for mathematics teaching in the primary schools.

In the case of incentive or reward, four suggestions were given and respondents were to add any additional rewards. About 30 percent of teachers and 34 percent of headmasters indicated a promotion prospect as a reward, while 32 percent of

teachers and 33 percent of headmasters asked for grades towards a certificate. There was a number of teachers, 43, who wanted both types of credits as a reward for successful attendance at inservice program. Only about eight percent of teachers, five percent of headmasters and an organizer indicated a certificate of attendance as the required reward. Table 18 gives a breakdown of the responses.

TABLE 18
Distribution of Responses Concerning the Credits to be Given for Successful Attendance at Inservice Programs

	Teachers		Headmasters		Organizers	
	No.	Pct.	No.	Pct.	No.	Pct.
A certificate of attendance. . . .	31	8.2	4	5.0	1	100
A reward towards promotion prospects.	114	30.1	27	33.8	0	0
A grade towards the attainment of a teaching certificate. . . .	120	31.6	26	32.5	0	0
An increment in salary	71	18.7	20	25.0	0	0
Other (please state)	43	11.4	3	3.7	0	0
TOTAL	379	100	80	100	1	100
No response:	1		0		4	

There was a unanimous agreement on the question of whether headmasters and school inspectors should participate in mathematics inservice program. Ninety-five percent of teachers, 95 percent of headmasters and an organizer responded that headmasters and school inspectors should participate.

Inservice Instructors:-Teachers were asked to rate four groups of people as inservice instructors in order of preference. The teachers of Teacher Training Colleges were the most preferred; followed by university lecturers and the well-qualified secondary school teachers in the neighborhood; and lastly by the school inspectors. Table 19 shows the mean distribution of the choice of instructors for inservice program.

TABLE 19
Preference for Inservice Instructors by the Teachers

Inservice Instructors	Mean	S.D.
Tutors from Teacher Training College.	1.90	0.80
University Lecturers.	2.40	1.26
Well-qualified Secondary School Teachers in the Teachers' Neighborhood	2.41	1.01
School Inspectors from the Ministry of Education.	3.20	0.95

No response: 3 in each case

Factors Affecting Wish or Ability to Attend Inservice Program:-In order that individual circumstances of teachers might be put into consideration as much as possible in designing inservice programs, teachers were asked to identify factors that could stop them from participating in inservice mathematics programs. Teachers checked some or all of five given factors that might stop them from participating, and were given a chance to indicate any other factors. These factors can be roughly classified into professional, domestic and financial factors.

On the professional factor, very few teachers indicated that inservice training was not helpful as shown in Table 20. However, the list of other factors given by teachers included a few professional issues such as non-availability of reward, lack of provision for follow-up and "inservice training not interesting." The financial factors such as cost of transportation to inservice center and fees charged for training programs would stop many teachers from participating. Sixty-three percent of teachers would not attend if they were to pay transportation cost that was too high, while 59 percent would not attend if fees were charged for the training program.

TABLE 20
Factors Affecting Teachers' Wish or Ability to Attend Inservice Programs

	Yes	%	No	%
Cost of Transportation	238	63.0	140	37.0
Fees Charged for Training Program	223	59.0	155	41.0
Family and Other Domestic Responsibilities	155	41.0	223	59.0
Dislike of Travel from Home	72	19.1	306	80.9
Inservice not Helpful	33	8.7	345	91.3
Others	32	8.5	346	91.5

No response: 2 in each case

The proportion of teachers who disliked travelling from home was smaller than those who would not attend due to financial reasons. Some other personal factors indicated included illness, mentioned by five teachers and seven teachers stated

motor accidents on the road as a factor that would stop them from attending inservice programs.

Women teachers more than men teachers mentioned "family and other domestic responsibilities" as a factor that could stop them from participating in inservice programs. The data showed that 34 percent and 50 percent of men and women respectively felt this factor could stop them. The differences were significant beyond the .01 level. Similarly, an analysis of differences between the subgroups of men and women showed significant difference on the item of "cost of transportation" as a factor that might impede attendance. There was no significant difference between men and women on other factors.

A further analysis of differences between urban and rural teachers on factors that might affect attendance at inservice program was carried out. There were no differences in responses on all indicated factors.

Evaluation of Inservice Effectiveness

The need for an evaluation of inservice training program had been highlighted through the review of literature. The absence of such evaluations is one of the problems plaguing inservice practices in Africa (Trevaskis, 1969). In order to find out what were the views and preferences of respondents on the process of evaluation in inservice program, they were asked to respond to the question: How should we decide on the effectiveness of an inservice mathematics program?

Preference for evaluation through the use of tests of mathematical understanding for the inservice participants and their pupils and through an evaluation of their classroom practices was expressed by 45 percent of teachers and 64 percent of headmasters. Table 21 gives further details of the analysis. Only four teachers wanted evaluation by practical teaching alone. There was no response from the organizer on this issue.

TABLE 21
Distribution of Responses on How Inservice Programs Should be Evaluated

	Teachers		Headmasters		Organizers	
	No.	Pct.	No.	Pct.	No.	Pct.
Through an evaluation of participant's understanding by giving him/her some formal and informal tests.	124	32.9	18	22.5	0	0
Through formal and informal tests for the participant, and other tests for the pupils he/she teaches	80	21.2	11	13.8	0	0
Through tests for participant and pupils, and through an evaluation of his/her classroom practices in teaching mathematics	169	44.8	51	63.7	0	0
Other (please state).	4	1.1	0	0	0	0
TOTAL.	377	100	80	100	0	0
No response:	3		0		5	

Demand for Future Courses

The different sections of the analysis so far seem to have indicated that although the periodic workshops and the occasional inservice programs organized for primary teachers are helpful, they are not enough. Many teachers and headmasters recognize this and they are eager to make up for their own inadequacy. Appropriately, many additional comments came from teachers in the last section of the questionnaire. One hundred and eighteen teachers or 31 percent of total number of teachers made additional comments. When the open-ended responses were analyzed, they were classified into four different but overlapping categories, all representing some forms of demand for future inservice mathematics programs. These categories are: (1) further suggestions on planning and organization, (2) call for governmental policy on inservice mathematics program, (3) the importance of the inservice program and (4) the need for appropriate remuneration for teachers. The following are examples of the demands in the words of the teachers under the specified categories:

1. Further suggestions on planning and organization--

   The inservice programme should be given a wide scope and attention. It should be made available to all teachers. It should be made interesting in order to remove the dislike that both teachers and pupils now have for mathematics.

   The course should be organized in every area both rural and urban. The government should support the programme.

   If the centre of the inservice training is within fifty miles to the stations of the participants,

many teachers will attend the course.

Well qualified teachers should handle the teaching of mathematics. It should be made practical and linked with everyday events.

I suggest we have regular refresher courses on mathematics. It should be regularly organized for teachers on new methods of teaching mathematics.

2. A call for governmental support and policy--

This course should be successful if the government or authority should not mind to run the expenses that it may cost.

In order to get a good result on this programme, the government should provide qualified teachers for the course. It should also provide useful teaching aids and create many centres in the state for the course.

To be more effective, I wish the Federal Government takes over the organization of the inservice mathematics programmes throughout the country.

3. Importance of the Inservice Program--

If this type of inservice mathematics program is intensified, it will go a long way to help many teachers who have no first class knowledge of this subject. The earlier the programmes start the better.

My comment is that this scheme should start quickly so that teachers can be in a better position to help the young ones who are to build the nation.

4. The Need for Remuneration to Teachers--

Future participants in inservice mathematics programmes whould be encouraged by the provision of (a) transportation allowance, (b) comfortable living accommodation for those who live far away from the centre, (c) an award of certificate leading to promotion and increment of salary, and (d) they should not be transferred too often from school to school.

I whole-heartedly support this programme but to make it a success please make arrangement for incentive to participants. Otherwise, teachers will be attending the course reluctantly and grudgingly and they

> may not benefit from it at all. They will leave the training centres and leave behind everything they have learnt.

The teachers' comments have relevance not only for the organizational aspects of inservice mathematics programs but also for some fundamental issues that are necessary for effective inservice programs. The issues touched upon by the teachers' comments include those related to cost of the program, adequate material and human resources, and above all, the need for definite governmental policy on inservice mathematics program. It is interesting to note that one of the teachers considered the need for mathematics retraining program great enough to demand not only a state government policy but a national government policy as well.

Another source of data on the demand for future inservice mathematics programs came from the responses of the headmasters in their answers to the questions on how the Institute of Education at Ife and the Ministry of Education can help them with their problems of arithmetic teaching. The headmasters' indicated needs ranged from the demand for the organization of inservice programs, the demonstration of the use of teaching aids, to the reward for successful attendance at inservice programs by the Ministry of Education.

The demand for future mathematics inservice program was well-expressed in the final comment of an organizing body who wrote:

> There is a genuine interest among primary school teachers. Take the help to them where possible -- make it available for all interested teachers. Selection of a few "favoured" ones does not encourage others to make an effort. Almost all primary teachers are mathematics teachers.

Discussion

This section of the analysis had dealt with views and preferences on mathematical content and other learning experiences, the organization of program and its evaluation, and the demand for future inservice mathematics programs. Just as classroom procedures and materials are important for successful mathematics teaching and learning, so is an understanding of the basic concepts of mathematics on the part of the teachers. As O'Daffer succinctly expressed this idea:[133]

> The good mathematics teacher: knows the children, knows mathematics, is skillful at involving children with mathematics, and makes use of his knowledge of the types of learning involved.

Mathematical topics for inservice program is in keeping with the international consensus on the mathematics content that elementary teachers should know (Howson, 1973). There is, however, no general agreement on the depth to which these topics should be treated in any teacher training programs. The findings of this survey seem to suggest that teachers should be helped to see mathematics as concerned with formulating and solving problems, through activity-oriented approach,

[133]Phares G. O'Daffer. "On Improving One's Ability to Help Children Learn," Arithmetic Teacher, Vol. 19, No. 11 (November, 1972), pp. 519-526.

covering at least the scope of work in the primary school syllabus.

Although teachers' preferences might not all be realizable in practice because of lack of resources and shortage of leaders, nevertheless, it is worthwhile that the preferences were established as a basis for planning. It is clear from these findings that teachers would like inservice centers located near their homes or towns. The preference of teachers on timing and duration is, however, not very clear. Majority of the teachers indicated preference for the one-shot, three-week course. This contradicts the earlier view expressed by teachers that refresher courses should last for a longer period and should have a follow-up. Furthermore, in the final additional comments, many teachers repeated their belief that a long-sustained program would be of greater help to them than the short courses. It appears from these data that a follow-up by a correspondence course is preferred to a follow-up by a radio course. Perhaps the non-availability of radio in some areas is a problem here. The choice of a correspondence course has both its advantages and disadvantages. Clearly, it offers the teacher an opportunity to learn and relearn the materials at his own rate, but for it to be effective, it must be well-planned, well-coordinated and it needs capital costs for equipment and materials. Whether by radio, correspondence or otherwise, follow-up activities undertaken regularly are crucial to the effectiveness of inservice programs.

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A trend in the analyzed data seemed to suggest that some teachers would prefer to have special teachers of mathematics in the primary schools. Although the use of special teachers of elementary mathematics is receiving increasing attention in some developed countries, yet such a practice will be unrealistic at this stage of educational development in Western State, Nigeria. First, the supply of mathematics teachers for the secondary level is still being met precariously. Secondly, research studies in societies where such special teachers have been used failed to show the superiority of the achievement of pupils taught by these special teachers of elementary school mathematics. Spitzer[134] reported a recent study based on special-teacher plan specifically set up to bring out superior achievement in elementary mathematics. The study found no greater achievement on the part of the pupils taught by these special teachers. In addition, such plans imply departmentalization of instruction at the primary school level and this might create other administrative and curricular problems.

As mentioned in the last section of this analysis, both intrinsic and extrinsic motivations are crucial to the successful practice of an inservice program. There is evidence from the data that teachers are intrinsically ready to participate in mathematics inservice programs. Their views on the extrinsic

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[134] Herbert F. Spitzer, Teaching Elementary School Mathematics: What Research Says to Teachers, No. 2 (Association of Classroom Teachers Material Education Association, Washington, D.C.), June, 1970, p. 17.

rewards were clearly made in terms of a recognized certificate or a reward towards a promotion prospect as opposed to the present practice of the award of a certificate of attendance. There is a growing dialogue among the Nigerian educators on how to reward a teacher's successful participation in an inservice program. The problems stem from the fact that most inservice programs are ad hoc, not systematic, not based on clearly defined goals, and they lack systematic evaluative process. A well-planned program should suggest evaluative measures by which the performance of the participants can be measured and adequately remunerated.

As Rubin[135] confirmed not all incentives have to be monetary. The recent economic development in the country, referred to in Chapter II, showed that a review of salaries have led to an increase in salary of primary school teachers since these data were collected. Nevertheless, there is still a place for the type of incentive that comes as a reward for superior teaching. Rubin added that this reward can be, "an honorific title like Master Teacher, if it carries sufficient distinction, might do as well as a monetary reward." This type of reward for teachers would necessarily be built on a performance-based criteria for superior teaching which could be established by the inservice organizers, school administrators and the teachers. The establishment of such a reward should give

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[135]Louis J. Rubin, op. cit., p. 247.

teachers added motivation to participate in inservice programs and sustain their interest.

The overwhelming choice of mathematics tutors of teacher training colleges as a preferred group of inservice instructors above the other groups is perhaps an indication of a long-standing need for a closer link between preservice and inservice training of primary teachers. Because of the scarcity of such teachers, however, there would be the need for a collaboration and coordination with other mathematics teachers at all other levels of education. Be that as it may, the establishment of inservice centers at the Teacher Training Colleges, the Advanced Teachers College, and the Institute of Education in the state should go a long way in providing some solutions to the problems of inservice training, especially because both physical and human resources could be shared for preservice and inservice programs. In general, one can make the conclusion from the survey findings that the primary teachers have the necessary readiness for the inservice mathematics education programs. Perhaps a further indication of this readiness and the willingness to be identified with a program of this nature were very well demonstrated in the responses to the last question in the questionnaires. Although the questionnaires were to be completed anonymously, 93 percent of teachers, 98 percent of headmasters and an organizer indicated their names and addresses in the optional space provided in order to have a summary of the survey findings.

SUMMARY OF MAJOR FINDINGS

The analysis of the survey data presented in this chapter revealed the following:

1. There are many problems of arithmetic teaching in Western State primary schools. Among them are: lack of qualified teachers, lack of teaching aids and other materials of instruction, and the lack of adequate provision for inservice training.

2. Some short inservice courses have helped teachers, while others have not.

3. Most inservice mathematics programs have been organized by the government and the universities.

4. A majority of teachers have never participated in inservice mathematics programs, but are willing and ready to participate in such programs in order to upgrade their mathematical knowledge and teach arithmetic better than they do.

5. Teachers' attitude and classroom practices in arithmetic teaching are generally favorable, but there is need for improvement. They lack adequate and appropriate materials of instruction including teachers' reference books and manipulative materials for the pupils.

6. Inservice learning experiences should include not only mathematics content but also content related to child development, use of materials of instruction, and classroom organization.

7. A majority of teachers would like inservice programs to take place close to their schools or towns. Many teachers are willing to travel a short distance to inservice centers, if financial and physical supports are provided.

8. The most common suggestions given by teachers, headmasters and organizers for the successful organization of inservice programs are (a) the programs should be extended to all teachers, (b) they should be long-sustaining, (c) instruction should be through practical approach with adequate provision for teaching aids, (d) appropriate evaluation should be planned and (e) arrangement should be made to remunerate teachers adequately.

9. The differences in the responses of different subgroups of teachers are not significant except in (a) the responses of lower and upper primary teachers in the choice of the topic -- Solid Geometry, (b) male and female teachers on "family responsibility" as a possible reason for non-participation in in-service mathematics programs.

CHAPTER V

A MODEL FOR INSERVICE MATHEMATICS EDUCATION

This chapter contains a description of the proposed inservice mathematics education model for primary school teachers in Western State, Nigeria. The model is based on a synthesis of findings from the review of literature, the survey findings, and the social and economic factors in the State.

RATIONALE FOR MODEL OBJECTIVES

As mentioned in Chapter I, the basic strategies for the design of the inservice model are flexibility and adaptability. Because of the differences between and among teachers, qualitative improvement in education never takes place on a solid front. There will always be individuals and institutions that adventure and explore and others that lag behind. This means that two opposing demands are made on a school system by any plan for curriculum improvement. First, it must be flexible enough to give the ablest teachers freedom to experiment and blaze the trail, and secondly, it must be ready to give the weaker teachers the guidance and support they need. Achieving the proper balance between these two demands, and adjusting the balance steadily as new generations of teachers who could take advantage of the new freedom arises, form important

basis for the rationale of inservice model objectives. In general terms, broad statements of objectives are given. Where specific outcomes are stipulated, the methods of approach to such outcomes are not rigidly specified and they could be modified to suit the conditions of different groups of teachers and school administrators.

The rationale for inservice model objectives is further based upon the fact that primary mathematics teaching in Western State is in a transitional stage. The inservice model programs should therefore help teachers to teach better what they are now teaching and at the same time help them towards the requirements of the future curriculum

A MODEL FOR INSERVICE EDUCATION

The inservice model presented here consists of four major processes. They include: (1) establishment of objectives for inservice training, (2) selection of learning experiences, (3) organization of inservice programs, and (4) a program of inservice evaluation.

Establishment of Inservice Objectives

Criteria for Establishing Objectives:-The first step towards meaningful, worthwhile inservice activity is the identification of the needs of teachers and other staff members (Harris and Bessent, 1969). To bypass this step, Harris and Bessent asserted, is like attempting to build a house without providing first a proper foundation. Therefore, a major criterion for the establishment of inservice model objectives was found in the

identified needs of teachers for the teaching of mathematics, which were analyzed in the preceding chapter. When stated in broader terms, the following criteria were considered in formulating the inservice model objectives:

1. To what extent has the proposed model identified teachers' needs? Teachers should be involved in defining and clarifying training needs. The design of training model must rest on this teacher involvement and attempt should be made to offer the training opportunity to all teachers.

2. To what extent does the training activities link cognitive and affective objectives of mathematics learning? A major concern of learning should be to activate and link the cognitive, affective and application aspects of the learner.

3. To what extent does the training program offer participants the opportunity to learn through the new approaches of mathematics teaching? The total sequence of inservice learning activities should be organized as problem-solving efforts in which the participants take initiative for inquiry.

4. To what extent does the training program allow for individual differences in teachers? The inservice program design should allow for and plan for individual differences in readiness, sophisticated and content needs of teachers.

5. To what extent does the training program plan for a follow-up? Provision should be made in the inservice model for appropriate continuing support of efforts the inservice participants make to use the training experiences.

6. To what extent does the training activity give promise of helping members with more than one aspect of their behavior? Effective inservice work in mathematics should focus not only on teachers' understanding of the structure of mathematics, the methods and materials of instruction, but also on theories on how children learn mathematics.

7. To what extent does the training activity support on-the-job experimentation? Inservice training is

not of much help unless participants feel they can try out new ideas in the setting where the problems which stimulated the training arose.

8. To what extent does the training activity contain provision for its own evaluation and self-correction? Unless members can discuss and criticize training activities, it is very difficult to improve them. Such evaluation helps to uncover new training needs for the future.

A Suggested List of Objectives for Inservice Mathematics Model:-The following are suggested general objectives for the inservice mathematics education model program of primary school teachers in Western State of Nigeria:

1. To promote a well-organized and carefully planned continuing inservice education program designed to upgrade the mathematical competencies of teachers towards the improvement of classroom instruction.

2. To suggest instructional and supervisory techniques and practices which have been found effective and calculated to meet local needs.

3. To stimulate a centrally-coordinated inservice program plan that can tap all resources, i.e., state and local governmental education bodies, teachers colleges and universities, teachers' professional organizations, mathematics associations, and civic organizations, in carrying out a continuing program of inservice education.

4. To stimulate the educational field in the preparation and production of instructional materials that may be produced on local or statewide basis.

5. To stimulate teachers and other staff personnel of the inservice centers in conducting action research, especially those related to how the Nigerian child learns mathematics, and in preparing evaluative instruments and tests.

6. To develop evaluative criteria for appraising the outcomes of the inservice education activities.

Selection of Learning Experiences

Objectives for Inservice Learning Experiences:-The model for inservice programs is designed primarily to help teachers improve their mathematical understanding and their classroom performance in the teaching of mathematics. The discovery or the activity approach required by the new approaches to mathematics teaching demands that the teachers play new roles in the classrooms. These roles include being a guide or a counselor whose main task is to stimulate pupils' activity and learning. Dienes[136] remarked that this is a very difficult role, since it requires the teacher to change personality, to change firmly fixed attitudes towards learning, students and objectives of teaching, and to refrain from being too much of a distributor of pre-organized knowledge as he may have been accustomed to be. The objectives of inservice learning experiences therefore include helping teachers develop behaviors that deal with the knowledge of mathematics as well as the techniques and procedures used in providing and managing instruction through the use of activity-oriented approaches. The following are representative examples of the objectives of inservice learning experiences stated in the form of the expected behaviors of the teacher:

Objectives related to the mathematics content --

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[136] Z.P. Dienes (ed.) Mathematics in Primary Schools. Hamburg: UNESCO Institute for Education, 1966, p. 102.

1. The teacher demonstrates mastery of mathematical concepts being studied by his pupils.

2. The teacher exhibits an improvement in his arithmetic skills and teaching methods by learning fresh approaches to old subject matter.

3. The teacher selects activities that help his pupils to achieve the objectives of the mathematics curriculum.

Objectives related to Teacher-Pupils Interaction --

1. The teacher does not criticize negatively a student's contributions to a group discussion or to other group work.

2. The teacher responds to student statements by asking for validation or justification of the mathematical ideas expressed.

3. The teacher asks questions and leads discussion, rather than "telling."

Objectives related to Class Practices --

1. Given an activity that requires pupils to work individually, in small groups or in large groups, the teacher organizes the students in the appropriate mode.

2. The teacher allows pupils to move purposefully about the room to obtain materials, to consult with others, or for other task-oriented reasons.

3. The teacher allows pupils to interact verbally while working on an activity.

4. Using the appropriate assessment instruments, the teacher assesses pupils' performance and completes performance record.

5. When presented with a pupil who has not mastered a mathematical objective, the teacher can choose an activity that will help the pupil reach that objective.

6. When given the appropriate information on pupil achievement, the teacher can classify pupils into two groups--those that have sufficient mastery of prerequisite behaviors to start a new topic, and those that do not.

Objectives related to the use of materials of instruction --

1. The teacher arranges the materials of instructions and furnishings in the classroom in a way that fosters learning.

2. The teacher makes use of concrete materials to simplify abstract ideas.

Consideration of Breadth and Depth of Inservice Mathematics Content:-A comparison of the list of mathematical topics desired by the primary school teachers[137] of Western State with two elementary school mathematics inservice programs showed its adequacy when the scope of topics covered were considered. Houston,[138] for example, suggested the following as the mathematics topics common to many inservice mathematics programs:

Elementary Set Theory
Distinction between conceptual notion and symbolization of that idea (number-numeral, operation-algorithm, line-representation of a line, etc.)
Number Systems, Numeral Systems
Equality, equivalence and inequalities
Properties of arithmetic
Operations with integral and rational numbers
Measurement and simple geometry
Problem solving and mathematical models

Similarly, the African Mathematics Program[139] suggested the following major mathematics topics for the inservice

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[137] See page 147 of Chapter IV: Analysis and Interpretation of Survey Data.

[138] W.R. Houston "The Challenge of Inservice Education," in Evelyn Weber and Sylvia Sunderlin (eds.) New Directions in Mathematics, Washington, D.C.: Association for Childhood Education International, 1965, pp. 65-70.

[139] African Mathematics Program, Education Development Center, Mathematics Syllabus Sourcebook for African Training Colleges (Inservice Courses), Newton, Mass.: African Mathematics Program, 1970, pp. 2-5.

program of teachers without a secondary education:

Set	Modular Arithmetic
Number	Multiples and divisors
Numeration	Primes and Composite
Fundamental Operations of Arithmetic	Divisibility Tests
Use of Properties to perform operations	Fractions
Fundamental Operations with fractions	Integers
Decimal Fractions	Rational numbers
Applications of Fractions to problems	Ratio and proportion
Non-metric Geometry	Parallel lines
Symmetry	Measurement
	Scale Drawing

Undoubtedly these different inservice programs had followed to a great extent the recommendations of the Cambridge Conference on Teacher Training of 1966.[140] However, even though there are several recommendations in literature as to what mathematics topics should be covered in an inservice program, there is little or no consensus as to the depth to which the topics should be covered.

Of great importance to any consideration of the content of elementary school mathematics today is the new movement of critics of the new mathematics. In the United States, for example, this movement has been so strong in some areas that it has been called "the Second Revolution in School Mathematics," the first being the new mathematics movement itself. Among these critics are parents and some teachers who are

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[140]Education Development Center, Inc., Goals for Mathematical Education of Elementary School Teachers (A Report of Cambridge Conference on Teacher Training), Boston: Houghton Mifflin Co., 1967, p. 26.

calling for the return to such basics as the multiplication tables. Professor Morris Kline, a notable mathematician who opposed the new mathematics from its inception, urges a new direction, "diametrically opposite to that taken by the new mathematics."[141] He maintains that the reason why the new mathematics is a failure is because it is directed towards the minute fractions of students who will one day become professional mathematicians. The rest of the students, he claims, are left with scarcely enough mathematical capability to perform simple arithmetic operations, and certainly not enough to fill out an income tax form.[142] Kline recognizes that the old methods of teaching mathematics were imperfect, but argues that rigorous theories and heavy reliance on terminology and symbolism are not the solutions. He calls on teachers to teach mathematics not for its own sake but as an integral part of the culture.

Appropriately, the mathematics educators are continually reviewing the programs for better mathematics teaching. An evidence of this continual search for improvement is in the recommendations of the Snowmass Conference on school mathematics curriculum in 1973.[143] The recommendations covered issues on goals, teacher education, evaluation, and the

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[141] Morris Kline, Why Johnny Can't Add: The Failure of the New Math, New York: St. Martin's Press, 1973, pp. 144-170.

[142] Ibid., (frontpiece).

[143] Mathematics Education Development Center, Report of the Conference on the K-12 Mathematics Curriculum, June, 1973, Bloomington, Indiana: Indiana University (mimeographed).

teaching of mathematics for a computer era. A very great emphasis was placed on the teaching of problem solving and on the applications of mathematics in the recommendations. A logical direction for action was well expressed by the New York teacher who stated:[144]

> We realize that part of the new math is very good and some of it is not necessary and some has to be phased out. We found that we can use the best of the new and the old.

The implication of the current movement for developing societies such as the Western State of Nigeria is far-reaching. Reforms in mathematics curriculum in these societies should borrow from the experiences of reformers of the last two decades in the more developed nations. The selection of mathematics content and methods for inservice training of teachers was, therefore, guided not only by the expressed needs of teachers for the understanding of mathematics but also by the utilitarian aspects of the topics, both to the teachers and the pupils.

Suggested Mathematics Topics for Inservice Mathematics Program:-The proposed list of mathematics topics for inservice program (Table 22) is designed in accordance with findings from the survey and the literature review; and the guidelines suggested by curriculum improvement programs in Nigeria. It encompasses ten units of work with an eleventh unit which

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[144]Cited in: Fred M. Hechinger, "Math: Integrating the New and the Old," The New York Times, Section 13, Sunday, May 4, 1975, p. 1.

consists of additional topics. The additional topics may be regarded as optional topics though they are recommended where and when teachers have the prerequisites for them. The order of presentation of units is not rigid. However, the measurement unit is deliberately named as unit one to reflect the need of teachers, and also that it might receive priority in program implementation. It is suggested that application to real life situation and problem-solving form important part of each topic treatment and that the technique of spiraling the curriculum will be used in carrying out inservice instruction covering the topics.

TABLE 22
Mathematics Topics for Inservice
Training Programs

Unit 1. Measurement

Non-Standard and Local measures
Metric System and Conversion--Length, perimeter, area, capacity, weight, and volume
Time, Temperature and Money

Unit 2. Numeration

Ancient numeration systems
Different numeration systems and place values
Local Nigerian number names and the grouping patterns

Unit 3. Set and Logical Games

Matching, Joining and Separating with limited use of notations and terminologies
Set Operations

Unit 4. Whole Numbers

Counting and One-to-One Correspondence
Order and Cardinality
The Number Line
The fundamental operations with whole numbers

Table 22 (cont'd.)

Unit 5. Common and Decimal Fractions

Meaning and Notations
Equivalent fractions
Decimal fractions
Fundamental operations with fractions
Ratio, Proportion and Percent
Application of fractions to problems
Making Estimations

Unit 6. Number Theory

Prime and Composite
Factors, Multiples, Divisors
Divisibility Rules
Exponents and Exponential notation

Unit 7. Basic Concepts of Geometry

Points, lines and planes
Parallel lines
Solid shapes
Simple Geometric Constructions including scale drawing
Symmetry and Congruence
Motion Geometry

Unit 8. Business and Civic Arithmetic

Discount, Profit and Loss
Simple and Compound Interests
Simple Cash Discount
Taxation, Electricity Bills, Rates, etc.

Unit 9. Statistics, Probability and Graphs

Pictorial Representation of data--
Bar chart, pictogram, line graph, circle graph
Interpreting graphs
Mean, median, and mode
Simple ideas of probability (experiments with coins and dice)

Unit 10. Problem Solving and Applications

Making up and solving mathematical sentences
Solving mathematical problems

Unit 11. Additional Topics

Topological Ideas
Equations and symbols
Formulae and Subsituations
Integers and Real numbers
Modular Arithmetic

Other Learning Experiences:-The International Congress on Mathematical Education identified three main strands as essential in primary school mathematics teaching. They are: mathematical knowledge, insight into children's learning and its goals, and classroom procedures and materials.[145] The in-service training program should therefore include other learning experiences in addition to the mathematical content discussed above.

Other learning experiences to be included in the in-service programs are outlined as follows:

1. The study of child development, learning problems of pupils and methods of dealing with them.
2. Teaching methods, aids and materials.
3. Planning and preparing for the lessons.
4. Methods of dealing with large classes including pupils with varying abilities.
5. Setting, marking and interpreting teacher-made tests and school examinations.
6. All other learning experiences required by teachers according to their immediate needs.

Whatever the choice of topics for a particular inservice program series, the content should help the participants with their teaching or other related assignments. Suggestions of various ways of teaching a mathematical topic should be given in the same lecture-discussion in which the topic itself is considered. This integrated approach to content and method in mathematics learning and teaching has proved to be effective

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[145] Howson, A.G., op. cit., p. 46.

in helping teachers improve their mathematical competencies as evidenced by the studies of McLeod (1965) and Hunkler and Quast (1972).

Furthermore, to insure the success of the programs, learning experiences must involve the participants in actively learning by listening, preparing notes, studying together, engaging in informal discussion, experimenting in workshop or laboratory setting, and reading and criticizing texts or other instructional materials. In other words, if activity-learning approach is to be transferred into the teacher's classroom, the inservice programs should give him such learning experiences.

Specific instructional strategies that have increased mathematics achievement of the learners should also form part of the learning experiences in the inservice programs. Reference was made in Chapter III to the method of guided discovery and the research findings on its effectiveness in mathematics teaching. However, if the method is badly handled it can result in a waste of time and even chaos. If well handled, it enables pupils' motivation to be discovered and accustoms them to purposeful activity, to team work and independent work, and to seeking and using knowledge. Again, to insure the advantages of the discovery approach in the primary classrooms, inservice experiences for teachers should include learning by discovery.

Two other instructional strategies that have effectively contributed to mathematics learning deserve to be considered

for inservice instructional strategies. They are the mastery learning approach and the programmed learning approach. Many studies carried out under school conditions indicate that mastery learning strategy has marked effects on the learner's cognitive and affective development and their learning rate. In its simplest form, the strategy, as proposed by John B. Carroll,[146] was based on the theory that if each student was allowed the time he needed to learn to some level and he spent the required learning time, then he could be expected to attain the level. However, if the student was not allowed enough time, then the degree to which he could be expected to learn was a function of the ratio of the time actually spent in learning to the time needed:

$$\text{Degree of learning} = f\left(\frac{\text{time actually spent}}{\text{time needed}}\right)$$

A corollary of this theory is that mastery learning strategies are designed to take into account individual differences among learners in such a way as to promote each learner's fullest cognitive and affective development. Further studies have also shown that mastery learning approach seems to help most students overcome feelings of defeatism and passivism brought to the learning situation.[147] The powerful affective consequences of mastery learning approach may be attributed to many factors, the most important of which

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[146] John B. Carroll, "A Model of School Learning," Teachers College Record, 64 (1963), pp. 723-33.

[147] James H. Block (ed.), Mastery Learning: Theory and Practice, New York: Holt, Rinehart and Winston, Inc., 1971, p. 96.

seem to be the cooperative rather than competitive learning conditions, successful and rewarding learning experiences, personalized attention to each student's learning problems, and the use of certain correctives (for example, student tutors and small group study sessions) which add a personal-social aspect to the learning not typical of group-based instruction.[148] Finally, a review of literature showed that the mastery learning approach makes student learning increasingly efficient, as the mastery of an earlier unit of work facilitates the learning of the subsequent units, especially where the learning units are sequentially arranged. An important aspect of this approach is in the pre-definition of what is regarded as mastery on the achievement test. Empirical work suggests that if students learn 80 to 85 percent of the skills in each unit, then they are likely to exhibit maximal positive cognitive and affective development as measured at the subject's completion.

Both mastery learning and programmed learning approaches break the subjects into a sequence of major cognitive objectives and develop programmed learning units for each objective. Unlike the programmed instruction, students using mastery learning approach do not proceed through the same programmed lessons. Each pupil's learning progress was constantly monitored, and, on the basis of his present and past performance, learning lessons were tailored to fit his particular needs.

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[148] Ibid., p. 97.

A basic idea underlying programmed instruction was that the learning of any behavior, no matter how complex, rested upon the learning of a sequence of less-complex component behaviors (Skinner, 1954; Gagne, 1965). By breaking a complex behavior down into a chain of component behaviors and by ensuring student mastery of each link in the chain, it would be possible for any student to master even the most complex skills. In practice, each component behavior is presented to the learner in a programmed learning unit. At the completion of the unit, the learner responds to a simple diagnostic question designed to indicate mastery or non-mastery of the behavior presented, and he is given immediate feedback on the adequacy of his response. If his response is correct, his learning is reinforced and he proceeds to the next learning frame or behavior. If incorrect, his error is immediately corrected so that misunderstandings are not propagated. However, the literature seems to suggest that programmed instruction worked well for some students, especially those who require small learning steps, drill and frequent reinforcement, but not so effective for all students.[149] Thus, while programmed instruction provides a valuable tool to help some students to attain mastery, it does not provide a useful mastery learning model. It appears that a combination of these and other strategies would provide the needed varieties of inservice instructional approaches needed to take care of individual

[149] Ibid., p. 5.

differences of teachers, and later, of their pupils.

The findings from the survey suggest the great need of instructional materials for mathematics teaching. Many specialized materials will be needed to implement mathematics teaching in the primary schools. Some materials can be bought and used as they are. However, many other materials of instruction will have to be adapted from the local environment, while others could be created by the application of imagination and skills. This process of adapting and creating materials of instruction and of learning the proper use of materials must form an integral part of inservice learning experiences. The following are among the potentially useful materials that might be incorporated into the inservice programs:

1. Construction materials for devices to be prepared by the teacher or by the teacher and the pupils.
2. Measuring devices, such as meter sticks and liquid measures adapted from local materials.
3. Wall charts (for example, those showing distances in metric units between some cities and other landmarks in the country).
4. Manipulative materials, such as the abacus, inch cubes, and different shapes of blocks.
5. Children's books, teachers' guides, and all available books on the teaching of mathematics in the elementary schools.
6. Films, filmstrips and tapes on mathematics teaching.

Organization of Inservice Program

The organization of the inservice programs presented in this model has two major stages: (1) the planning stage, and

(2) a suggested program procedure. Each stage has several components which should be related and continued all through the implementation process of the model.

<u>Planning for the Inservice Program</u>:-The main principle adopted for inservice planning in the model is the involvement of all parties concerned, most especially the teachers. The task of promoting inservice growth amongst teachers, as evidenced in the reviewed literature, is too significant and vast to be left to any one single agency or to be handled by the different agencies each working in isolation, as the present situation in the Western State seems to suggest. It requires the concerted efforts on the part of a large number of agencies and institutions engaged in the task of improving instruction in schools and providing for professional growth of the teaching personnel. Such agencies in the Western State of Nigeria include teacher training institutions, the Inspectorate Division of the Ministry of Education, the State University Institute of Education, professional organizations, Parent Teacher Associations, and the universities. All these different agencies should come together and plan jointly in a systematic manner, taking into consideration the resources and priorities, so as to avoid duplication and waste. Briefly, this model calls for a centrally coordinated organizational approach to inservice mathematics education characterized by a variety of activities embracing the efforts of the central office personnel at one end and those of the local school

centers at the other. The central office personnel for inservice programs should be composed of the State Ministry officials as well as representatives of the different agencies mentioned above. The main seat of the inservice central-coordination body should be in the State Ministry of Education, but there should be a liaison between this office and the teacher training institutions.

A wide variety of decisions about the inservice training programs have to be made at this level. The keynote of the decision-making process is that it should be shared by all, including the teachers for whom the program is planned. The following are among the typical areas on which decisions should be made in the planning stage: (1) special roles of the different agencies, (2) selection of inservice participants, (3) selection of time, (4) physical facilities, (5) content of the inservice program, and (6) program procedure.

(1) Special Roles of Different Agencies:-Each agency in this coordinated venture has cricial roles to play. The Ministry of Education, for example, would have to contribute significantly to decisions in the areas of timing, especially if some aspects of the program have to be carried out during the school hours; on the strategies for the provision of commercially produced materials of instructions and their funding; on inservice follow-up supervision; and on the issue of remuneration for successful participation of teachers. An outstanding suggestion from this study is the use of

honorary promotion based on an evaluation of the teacher's classroom performance as a result of his participation in the inservice mathematics program and perhaps programs in other disciplines.

The Teacher Training Colleges, the Institute of Education and the universities should play a greater role than the other agencies in developing and implementing specific inservice programs. Three important reasons for the choice of teacher training institutions in developing such programs of inservice education are:

1. They are engaged in the task of teacher preparation at the preservice level, so they would naturally have the advantage of understanding the academic and professional background of teachers.

2. They have the qualified staff to impart the required inservice training.

3. The teacher training institutions themselves would get vitalized through live contact with schools through the program of inservice education. The constant flow of ideas from the field would also enrich the program of teacher preparation at preservice level.

The professional organizations such as the Western State branch of the Nigerian Union of Teachers and the Mathematics Association of Nigeria can and should play important roles in planning, developing and implementing inservice mathematics programs. In addition to being sources for inservice instructors, they can also promote new developments in the teaching of mathematics through their conventions, seminars, workshops and discussion groups. The identification of the basic problems of mathematics teaching in the field through

indepth research studies should be shared especially by the professional organizations as well as the teacher training institutions.

An important phase of the planning procedure is the identification and establishment of a corps of inservice instructors. These people have special roles to play in the program. They can be selected from the groups of mathematics teachers in the Teacher Training Colleges, secondary schools and universities, from members of a professional organization or from the officials of the Ministry of Education. The important criterion in this selection is that the inservice instructor should be a master of both the content of mathematics and the methodology of mathematics teaching.

The success of the inservice programs rests on the involvement of the teachers and the headmasters in the schools. Therefore, they should play important roles in planning, participating actively, and implementing the inservice programs.

The roles of parents and community leaders in inservice training programs either through Parent Teacher Associations or otherwise should not be underestimated. The importance of a supportive home and community environment to the quality of classroom instruction has been well expatiated in literature. In this particular case, an area in which a strong community support can be of help to inservice program is in the production of materials of instruction. The last few years have seen great development in the wood and plastic

industries in the Western State as well as other parts of Nigeria. A collaboration of some private, governmental and educational institution ventures could appropriately lead to the mass production of useful educational teaching aids which are very much needed for quality teaching, especially for the teaching of mathematics. In addition, parents can help in the production of low cost, easily made teaching aids.

Further community assistance in the area of materials of instruction might be in the form of donations of technological aids such as radios, televisions and mobile libraries to teacher training colleges and other inservice centers. Community leaders in Nigeria have been known to donate public transportation for use in educational institutions of higher learning. If the needs and objectives of inservice training programs for primary school teachers are made known through involving the leaders in the planning phase, the community is a significant source of assistance that may cut down on the cost of inservice training programs. In addition, teachers need both the social and moral support of the community in order to implement any new program in the school system, hence the important role of the community in both the planning and subsequent phases of the inservice programs.

(2) Selection of Inservice Participants:-The findings from the survey suggest that all primary teachers should participate in the inservice mathematics education. Nevertheless, it is necessary to make decisions on how to orchestrate the programs in order to reach all categories of

teachers. A variety of suggestions from the literature reviewed should be considered for decision-making on this issue. Among them are the following: (1) selection of participants for different stages of the inservice programs from lower primary teachers or upper primary teachers, (2) selection of new teachers or teachers with many years of teaching experience, (3) concentration on teachers in rural centers or in urban centers, and (4) the selection of participants from among headmasters and teachers, who could later organize other phases of the inservice programs.

(3) Selection of Time:-A great consideration should be given to time arrangement for the inservice programs in the planning stage. Questions such as the following should guide the decision on timing arrangement: How many sessions will there be? Will the sessions be held on or off the school time? If one lengthy session is organized over a vacation, when should the short periodic sessions come?

(4) Physical Facilities:-That the success of any inservice program is largely dependent upon the availability of various kinds of physical facilities has been discussed in the earlier chapters of this study. Decision-making areas include: Should sessions be held at school, at a central place (community headquarters), in the nearby Teacher Training College, or in the Institute of Education? What room arrangement will meet training needs best? What audio-visual equipment can and should be made available? What use could be made of the existing facilities, even if it means sharing

with another educational program? Should existing facilities be altered for inservice needs or new ones developed especially?

(5) Content of the Inservice Program:-The preceding section of this chapter has discussed what should be the content of inservice mathematics programs at length. At this planning stage, however, consideration should be given to a breakdown of the learning activities so that the details of the activities for each inservice session are identified. Such details might be planned by committees of the central inservice planning team according to the backgrounds and needs of the particular group of teachers for whom the program is planned. There is need to emphasize that such detailed program should integrate the subject matter, method and materials of mathematics teaching. It should put cultural factors, such as language, into consideration in planning inservice courses for teachers.

(6) Program Procedure:-This is a more specific phase of the planning program than the general planning procedure discussed so far. Specific decisions are needed on what procedures should be adopted for the inservice sessions to meet particular needs. Should the group work as a whole? Should the program be conducted in a laboratory or workshop setting? Can demonstrations be given with a real class of pupils? How should follow-up be organized? What data should be gathered before, during and after the sessions for the purpose of evaluation? Who should be responsible for such data-collection and how should it be done?

The questions for decision-making are many and complex but are vital issues in planning if inservice training programs are to be successful. The following section of this chapter gives specific suggestions for the program procedure of inservice mathematics education in the Western State.

A Suggested Program Procedure:-In this part of the study, the findings reported in the earlier chapters are used in suggesting a specific program procedure. Such program procedure should be preceded by the type of planning procedure described above. The suggested program procedure delineates briefly on the following aspects of the mathematics inservice training programs: timing, place, inservice staff, inservice program activities, follow-up activities and evaluation.

(1) Timing:-A long-sustained one-year program is proposed. Tabel 23 shows a sequential design chart for the inservice program procedure. A minimum of 102 hours of learning experiences is suggested in the sequence. At the rate of three hours of group meeting in a week, there is a total of 34-week work in a period of one year. The time is regarded as adequate when compared with timing practices in other inservice designs. For example, the University of Illinois Arithmetic Project Institute for Elementary School Teachers of grades 1-6 suggested ten to nineteen weekly sessions, each with a duration of 1½ to 2 hours.[150] However, background and needs of teachers should be borne in mind when considering such comparison.

[150] J.D. Lockard, op. cit., p. 846.

TABLE 23
A Sequential Design Chart of Inservice
Mathematics Program Procedure

Time Period	Place	Program Activities
Long Vacation (July-September): Two weeks of at least 10 days. Six hours of planned inservice activities each day.	Teacher Training Colleges, Advanced Teachers College, Institute of Education	Preassessment of Participants. Planning for learning experiences Preparation and Orientation Learning experiences: Course lectures in large group, small group, individual; Tutorials, group discussion, Workshop activities, demonstration classes, making teaching aids, films, tapes, special lectures and other activities.
First Term (September-December): Two one-day week-end meetings, each of six hours duration.	Teacher Training Colleges, Advanced Teachers College, Institute of Education. Other existing Inservice Centers. Any local center that can be arranged e.g., a school or a community center	Diagnosis Enrichment, practice or relearning New learning experiences Formal and informal evaluation--Formative
Second Term (January to March): Three one-day week-end meetings, each of six hours duration	(as for first term)	Diagnosis Enrichment, practice or relearning New learning experiences Informal Evaluation
Third Term (April to July): two one-day week-end meetings, each of six hours duration	(as for first term)	Diagnosis Enrichment, practice or relearning New learning experiences Summative Content Evaluation Planning for the second year*

*The Second Year procedure is chiefly for follow-up, supervision and evaluation of classroom practices. Subsequent years will be characterized by self-directed follow-up.

(2) Place: The twenty-three Teacher Training Colleges in the State, the Advanced Teachers College and the Institute of Education are suggested as centers for the inservice programs. It is proposed that the two-week work should be intensive but at the same time interesting to teachers. In order to discourage "moonlighting," it is proposed that this main section of the program be residential. The suggested locations should have available physical facilities which can be used by inservice participants because the schools would be on long vacation which lasts from mid-July to mid-September. It is suggested that the program be offered free to teachers, except for the cost of books and other writing materials which teachers should be responsible for.

As much as possible the follow-up sessions during the school year should be located close to the teachers. The vacation centers would still be used non-residentially during the school year. The week-end is suggested when there would be greater opportunity to use the physical facilities of the preservice programs. The use of local centers should make it possible for teachers to avoid any long journey for the one-day sessions.

(3) Inservice Staff:-The crucial role of the inservice instructors has been mentioned earlier. Other staff members needed for the program are a director, tutorial leaders and a secretary or other assistants. These staff members would have been identified at the planning stage.

The director of the program must be ready and able to assume primary responsibility in the planning, organization and operation of the inservice programs. It is he who with the other program officials must carry out the decision of the central-coordinating body. The administrative responsibility of the director extends from the central office to the supervision of the local centers, the local instructors and tutorial leaders and other assistants. His duties begin at the planning stage and continue until the program is evaluated and reported to the central body.

A continuous chain of communication and planning for learning experiences would have to be initiated among the inservice instructors. This might be done through instructors' meetings and workshops which would further familiarize all instructors with the content, method and materials of primary schools mathematics teaching.

(4) Program Activities:-The program of the inservice sessions will usually consist of some or all the activities indicated in Table 23. The major content of the program may be one or more organized series of lecture-discussions on mathematical topics identified earlier in this chapter. They may be followed by workshop or laboratory experiences for the participants. Inservice learning experiences and instructional approach for mathematics teaching were discussed in the second section of this chapter. However, increased knowledge of group procedures and working with adults has relevance for the methods of organizing inservice program activities.

Although there was no attempt to investigate the ages of teachers in the study, the findings on the teachers' years of teaching experience suggest an age range of about eighteen to fifty years. A review of literature shows that continued attention is being paid to the adult learner. A few studies and theories, such as those of Rogers (1951), Houle (1961), Tough (1971), and Knowles (1973), have demonstrated that given the appropriate learning climate the adult learner will learn and achieve both cognitively and affectively. Tugbiyele (1970), with many years of adult teaching experience in Nigeria and Zambia, confirmed the universality of Houle's findings. Houle's study was designed primarily to discover why adults engage in continuing education, but it also explained how they learn. Through an involved process of the analysis of characteristics of adult learners uncovered in his study, Houle came to the conclusion that adult learners are of three categories: the goal-oriented, the activity-oriented and the learning-oriented adult learners.

The staff of the inservice education program has, therefore, to carefully select or combine methods for inservice program activities and use them to elicit the best results. The methods should satisfy the well-accepted principles of group involvement, for example:

1. Involvement of the participants and providing them with opportunities to grapple with the different problems they are facing.

2. Climate of freedom to express themselves.

3. Opportunities for creativity.

4. Sharing responsibilities.

5. Giving opportunities to people to relate themselves to others.

6. Attending to individual and group problem-solving processes.

7. Creating the atmosphere which is conducive to building mutual respect, support, and creativeness.

8. Developing the simplest possible means to secure actions through group decisions.

9. Encouraging teachers to test and try out ideas and to plan in real situation, etc.

In the light of the above and other principles, it is to be decided whether workshop, group discussion, role playing, films and tapes or any combination of these activities will be suitable to deal with a particular topic. One good strategy may be to involve the participants in deciding what procedure should be adopted, as indicated in the chart. It will bring greater participation from the group members.

(5) Follow-up Activities and Evaluation:-There can be no guarantee that the learning experiences acquired during the inservice sessions will be transferred into the classrooms if follow-up activities are not undertaken regularly. The implementation of ideas or experiments by a particular participant may be postponed because of a difficulty he faces, the solution of which appears to be beyond him. A timely help at this stage through the visit of any of the staff members of the inservice program or through correspondence can help him continue with his project. It is, therefore,

necessary to keep in constant touch with the participants, especially at the initial stage of their introducing the program ideas in their classrooms.

Follow-up activities also have the great advantage of providing insights to the planning body in its own organization which can help in vitalizing the future programs. The following methods are suggested for follow-up activities: visits, correspondence, teachers' reports and radio programs. Adequate consideration should be given to follow-up and evaluation approach during the planning stage.

The follow-up visits should not be left to the Ministry officials alone. Plans should be made to involve as many of the instructors as possible in the school visits at different stages. Follow-up by correspondence can range from personal letters, newsletters, or in fact a form of programmed instruction giving further explanations, giving depth to an earlier idea or explaining a new concept. Although not many schools have radios, many homes have radios. The Western State radio station currently transmits a program for teachers. The same avenue can be used for inservice follow-up sessions, perhaps in the form of a "question and answer" program or otherwise.

As Table 23 indicates continuous evaluation is an integral part of the learning experiences. While some of the suggested evaluation are meant to diagnose weaknesses that should be strengthened, others are to check if the specific learning objectives are achieved. The needs and points of

weaknesses discovered during the follow-up are considered for remedial work in subsequent activities and hence the follow-up practices form part of the evaluative process. Further discussion on evaluation follows in the last section of this chapter.

A Plan for Inservice Evaluation

Evaluation has been defined as "the determination of the worth of a program, product, procedure, or objective, or the potential utility of alternative approaches designed to attain specified objectives."[151] The importance of evaluation in inservice training program cannot be overemphasized. Allen (1971) referred to evaluation as the pivotal point of any teacher training program, be it preservice or inservice, that takes change and self-improvement seriously. He further identified at least four major roles which evaluation should play in the organization of inservice training programs. These roles are summarized as follows:

1. To provide diagnostic procedures which are continually necessary to assess the extent to which teachers in the field have met the various criteria appropriate to their roles, and to new roles they might wish to assume.

2. To help administrators determine which teachers have met which performance criteria, so that they can be placed in the appropriate educational role with the appropriate rewards for their professional talents.

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[151] Blaine R. Worthen and James R. Sanders, Educational Evaluation: Theory and Practice, Worthington, Ohio: Charles A. Jones Publishing Co., 1973, p. 19.

3. To offer a systemmatic means of assessing and researching the appropriateness of the teacher performance criteria employed by the program.

4. To help in developing self-regulating research models which will be used in making decisions on the effectiveness of inservice training methods and procedures.

From these stated functions of evaluation, it can be concluded that evaluation of the inservice programs is not synonymous with the giving of paper and pencil tests. It can also be asserted that the scope of the program of evaluation will vary directly as the scope of the specified objectives.

Criteria for a Program of Evaluation:-The following are some criteria for a comprehensive program of evalustion:

1. Is the evaluation program consistent with the stated objectives?

   Evaluation should be based on what is expressed as significant achievement in the objectives. If learning program emphasizes mathematical competencies, attitudes towards mathematics, and instructional materials, the evaluation program should not be limited to achievement tests. It should use a variety of instruments and techniques of evaluation.

2. Does the evaluation program include a comparison between the learner's performance before and after the learning situations?

3. Is the evaluation process continuous?

   Evaluation should not be limited to an after learning test. It should be carried on continually with the progress of the learning programs. This is especially significant if techniques such as observation, anecdotal records, and performance tests are used for evaluation.

4. Are the instruments used for evaluation reliable and valid?

   Reliability refers to stability or consistency. Test reliability is the consistency of scores

obtained by the same persons when retested with the identical test or with an equivalent form of the test.[152] Validity refers to the degree to which the instrument actually measures what it purports to measure.[153]

5. Does the evaluation program help to initiate further steps in the development of educational project?

   A successful evaluation program wields further attempts to improve learning experiences and, in general, the educational program.

With these criteria in mind, a description of an evaluative procedure follows.

A Procedure for Evaluation:-The inservice mathematics education programs which have been described in this model have two major purposes: that of helping the primary school teachers develop mathematical competencies needed for their professional roles and of improving the quality of mathematics teaching in the primary schools. The model, therefore, should be evaluated for these two purposes. The evaluation procedure should consider the quality of behavior change in teachers as individuals and as professional persons; and the nature and quality of the changes made in the program of instruction.

Two areas of evaluation emerge. One area is specific to the teacher and his teaching practices, while the other is general, comprehensive in nature, and relating to the overall inservice education programs. Each of the two areas

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[152] Anne Anastasi, Psychological Testing, New York: The MacMillan Company, 1961, p. 28.

[153] Ibid., p. 29.

should have two aspects of evaluation frequently referred to as formative and summative after Scriven's explication in Methodology of Evaluation.[154] Formative evaluation is a diagnostic-process test used to determine what has or has not been mastered at different stages of instruction. It provides an invaluable feedback to the instructor by identifying particular points in instruction that need modification. On the other hand, the summative evaluation provides a final appraisal of the whole program of instruction. Both formative and summative evaluations should form significant aspects of the different inservice program components.

(1) Evaluation Specific to the Teacher:-As indicated in Chapter III, a substantial amount of research has shown that teacher characteristics do not seem to be related to teacher effectiveness, though certain teacher behaviors apparently are. To put it another way, the crucial point in teaching mathematics in the primary schools seems to be what the teacher does, not just how much he knows. Therefore in evaluating the inservice program, the main evaluation technique to be used in checking objectives specific to the teacher should be classroom observation of what he does.

While observation is suggested as the basic technique of evaluation, other techniques should also be used,

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[154] Michael Scriven, "The Methodology of Evaluation," Perspectives of Curriculum Evaluation, R.E. Stake (ed.), Chicago: Rand McNally and Co., 1967.

following the recommendation that multiple measurements of phenomena should be used where possible (Webb, Campbell, Schwartz, and Sechrist, 1966). These other techniques should include questionnaires, interviews, rating scales, and different forms of formative and summative tests.

Though the effectiveness of the inservice programs on teacher's classroom practices, attitude, and the use of materials of instruction could be assessed through well-planned observation schedules, the teacher's understanding of mathematics concepts would need other evaluative methods in addition to classroom observation. The review of literature shows that a variety of tests of mathematical understanding have been effectively used to measure mathematics understanding of inservice teachers. An example of these tests is Dossett Test of Basic Mathematical Understandings.[155] Appendix D contains a modified version of this test adapted by the investigator for use with the model presented in this study. There are two forms of test. Form A is a pretest for use in the pre-assessment session and Form B is suggested as a summative test (see Table 23).

(2) General Evaluation Procedure: The general overall evaluation is all embracing. It should be done by examining both the institutions and the participants of the inservice program, as well as the different dimensions of the program. These dimensions consist of (1) general program objectives,

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[155] Mildred J. Dossett, op. cit., pp. 182-203.

(2) the learning experiences for participants, (3) organization of program, and (4) the end results of program, that is, the degree to which the objectives of the program are achieved and the efficiency with which the program permits the achievement of the objectives.

The methods of evaluation should include the use of interviews, questionnaires and observations. Other evaluative materials should include statements of attitudes of participants before and after the program; an inventory of teaching aids available to the teachers and their degree of use before the program and at periodic sessions afterwards; a critique of book-type materials and methods of using them; and school documents kept by teachers to report and analyze their experiences in teaching mathematics. Further evaluation process should include the collections of examples of good and poor teaching of mathematics and of common difficulties and solutions; tests of mathematics competence given to the pupils; and records of formal and informal research undertaken by field participants as a result of involvement in the project.

Again, the task of evaluation of the inservice programs cannot be left to one category of individuals. It should be a coordinated enterprise of everyone connected with the project. It is most important that regular contact be maintained between the inservice centers, the instructors, the Inspectorate staff and the participants, particularly when participants are back in the field.

SUMMARY OF THE CHAPTER

In this chapter the model for inservice mathematics training was described. This model is based on the findings from the survey, the review of literature and on the social, economic and educational trends in the Western State.

The chapter included: (1) rationale for model objectives, (2) the description of an inservice model, and (3) the summary of chapter. The model for inservice mathematics program described in the study consisted of the following major components: (1) the establishment of inservice objectives, (2) the selection of learning experiences, (3) organization of the inservice programs, and (4) a plan for inservice evaluation. A list of mathematics topics for inservice programs was developed in ten units, with an additional unit of optional topics. A modified form of Dossett Test of Basic Mathematics Understanding is suggested for a summative evaluation of teachers' basic mathematics understanding.

CHAPTER VI
SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter provides a general summary of the study, the conclusions drawn, and recommendations related to the implementation of the developed model for inservice mathematics education of primary school teachers in Western State of Nigeria.

SUMMARY OF FINDINGS

The purpose of the study was twofold. First, it was to survey the organization of inservice mathematics education for primary school teachers in Western State of Nigeria, to evaluate teachers' degree of involvement in such programs, and to investigate the views and preferences of teachers, headmasters and organizers on inservice mathematics education. Secondly, the study attempted to build a model for inservice mathematics education of primary school teachers based on the findings from the survey, the reviewed literature, and the social, educational and economic trends in the state.

The study used the research procedures of documentary analysis, questionnaire, official correspondence, and the review of literature. A historical analysis of primary education and primary teacher training programs was made. Current mathematics programs in the schools and the teachers

colleges were analyzed and described. The analysis was made with reference to current mathematics curricular development work in the state and in Nigeria. Problems of instructional quality especially in arithmetic teaching were raised with a focus on the role that inservice training programs could play in alleviating the problems.

An intensive study of international trends in inservice mathematics education for elementary school teachers, especially trends in the United States and Great Britain, suggested guidelines for the development of an inservice model. Literature was also reviewed in the area of cognitive development, mathematics learning, and on planned educational change. The analyzed survey data confirmed the existence of many problems of arithmetic teaching in the state's primary schools. The identified needs of the teachers and their preferences for inservice organization, coupled with the views expressed by the headmasters and organizers, provided basis for the development of the inservice model.

A crucial aspect of the designed model is the insistence on the need for important decision-making towards the organization of a systematic inservice mathematics education for primary school teachers in the state. The suggestion was made for a central-coordinating inservice body with representations from all the institutions involved in any aspect of primary education. Other policy decisions called for by the model were related to timing of inservice, remuneration for teachers

based on some performance criteria to be established, and the production of materials of instruction for the schools. Procedurally, the model described objectives for the general program, suggested some specific objectives for mathematics and other learning experiences, and highlighted three other major components, namely: planning, organizing the programs, and evaluating the programs.

CONCLUSIONS

The analysis of data obtained in this study and presented in the preceding chapters appears to warrant a number of conclusions. These conclusions seem reasonable on the basis of evidence obtained from (1) a review of literature, (2) the findings of the survey and the existing social and economic setting in the Western State.

A review of literature pertinent to the present study revealed numerous findings in the area of inservice education and the teaching of elementary school mathematics. A few of the important findings are cited below:

1. Many approaches are being practiced in inservice mathematics education with considerable degree of success. These have included national, statewide, and local school districts programs.

2. National and statewide objectives and policy for mathematics inservice education have been laid down by governmental bodies and have been vigorously supported with provision of funds. Policies are continually revised in the light of achievements or failures in inservice objectives.

3. Given teachers' readiness and motivation, supportive physical facilities, and human resources, some

benefits for the school system have resulted from the inservice programs.

4. For maximum benefit, inservice should relate to needs of teachers, and should involve teachers actively both in planning and in implementing the program.

5. Evaluation of inservice practices and their outcomes is regarded as important everywhere. Continuous attempts are being made at such evaluations through systematic and comprehensive research relative to the inservice methods and to the different mathematics instructional approaches.

Conclusions which were outgrowth of the findings from the survey were:

1. There are acute problems of arithmetic teaching in the state's primary schools. They include the lack of various materials of instructions and teacher's poor background knowledge for mathematics teaching.

2. Opportunities for retraining in this discipline have been scanty and have not reached many teachers.

3. A majority of the teachers expressed readiness and willingness to attend inservice mathematics program in order to upgrade their mathematical knowledge and to teach arithmetic better. They realized that the short periodic inservice days now and then are helpful, but not enough to meet their great needs.

4. It appears that there is an absence of a definite policy for a systematic retraining of primary teachers in the area of mathematics. The present practices are diffuse, uncoordinated and ad hoc.

Taking into consideration the different patterns and practices in inservice mathematics education across national boundaries, as well as the significance and needs for quality mathematics teaching in the Western State primary schools, the retraining program was formulated in accordance with the following parameters:

1. The inservice programs should be long-sustaining, at least through one school year period, with a variety of follow-up activities in the subsequent years.

2. Primary school teachers should have broad minimum competencies, not only in the subject matter of mathematics relevant to the primary school syllabus, but also in related areas of child development, new techniques of teaching, materials of instruction and effective classroom practices.

3. The procedure of the inservice programs should emphasize the inquiry/activity approach to learning mathematics and the application of mathematics to other disciplines as well as to everyday life.

4. The organization of programs would involve needed decisions, adequate planning and continuous evaluations.

RECOMMENDATIONS AND IMPLICATIONS

Numerous sources both in and outside Nigeria have pointed to the critical need for systematic inservice training programs to upgrade the primary teachers' inadequate background training in every field of learning. Education and World Affairs Committee in concluding its 1967 report stated:[156]

> The poor preparation of those now teaching in Nigerian schools must be remedied through intensified inservice training programs. Such programs will be effective only if they are well-coordinated and well-staffed and appropriate incentives are provided for those who make the effort to upgrade themselves.

Lewis[157] had earlier suggested that inservice training for primary teachers with deficient training background could be organized in stages. "The first stage might consist of

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[156] Education and World Affairs (1967), op. cit., p. 127.

[157] L.J. Lewis, "Inservice Teacher Training," Teacher Education, Vol. 3, No. 1, May, 1962, pp. 5-8.

inservice courses to help the teachers already in the schools to improve their own knowledge of subject matter, to increase their understanding and appreciation of the teaching materials they use, and to improve their teaching skill."[158] His suggested second and third stages were for curricular revision and completion of the inservice phases respectively. As a final example, the recommendation of Taiwo Commission mentioned in Chapter II included:[159]

> There should be inservice training programme aimed at depth and professional competence.

The present study represented an attempt to develop a model inservice program for a systematic upgrading of primary teachers' competencies in the area of mathematics. Given the present social and economic setting in the Western State, the societal aspirations and the available human resources, even though limited in some ways, it is affirmed that such an inservice program plan is both feasible and practical. What is needed is a concerted effort of all groups interested in improving the quality of mathematics teaching, indeed of education in general, in the primary schools. These efforts will necessarily include adopting new rules; prescribing new procedures; changing and providing materials, altering the functions of some officials, or creating temporary organizational structures such as experimental or pilot programs.

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[158] Ibid., p. 6.

[159] Taiwo Commission Report, op. cit., p. 28.

Above all, these approaches must be guided by constant encouragement, stimulation, and morale-building directed towards the acceptance of improved practices.

Recommendations and implications from the present study are therefore given in four categories: (1) recommendations for implementation, (2) recommendations for primary teacher training, (3) implications for primary education, and (4) implications for further research.

Recommendations for Implementation

To be effective, the inservice model described above would need the adoption of certain governmental policies to guide its planning and procedures. The major principle on which the model rests is that of resource integration. There is need for a central body that would guide such integration and coordinate the different inservice activities at the central and local levels. Major policies are also needed on how to reward teachers and on the production of instructional materials. The following recommendations are based on the investigator's interpretation of the findings of the study and the requirements of the model.

Recommendations for Decision-Making:-

1. A Central Inservice Coordinating body with membership as described in the model should be established for the purpose of coordinating inservice program endeavors.

2. In terms of both developing inservice training and keeping valuable talent in the primary schools, the state should begin to employ evaluation and

promotion procedures based on performance rather than on time criteria.

3. Material production centers should be established in the state for the design, testing and the mass production of teaching materials.

4. Quality inservice education of teachers should be an integral part of the primary school mathematics program.

Recommendations for Program Organization:

1. The Central Inservice Coordinating body should plan for program, especially coordinating plans for urban and rural areas.

2. The details of the learning experiences should be planned in a central institution, where organizing and planning staff should be responsible for preparing the course materials in consultation with experienced and qualified teachers in the universities, colleges and schools. The course materials should be an integrated whole, but prepared in the ways appropriate to the form which the training takes, i.e., residential and non-residential weekend and vacation courses, correspondence courses or broadcast programs.

3. The participants should be grouped for programs by class levels (lower or upper primary). Other subgrouping should be considered by the planning body.

4. A variety of methods of inservice education including seminars, workshops, symposia and lectures should be planned for and employed.

5. The programs should be planned with adequate provision made for all human and physical resources.

6. Adequate time should be allowed for planning before the first phase of the actual programs.

7. Provision should be made for follow-up and the evaluation of the programs at all levels.

8. The inservice programs should be initiated with a small group of teachers in its first phase. Reports of experiences should guide subsequent expansion.

Recommendations for Primary Teacher Training

The sample selected for the present study was limited to Grade II and Grade III teachers and to the teaching of mathematics in the primary schools. It is however, recognized that primary school teachers as generalist teachers have needs for upgrading in other areas of knowledge. Also, the survey findings showed that there are many untrained teachers who could be provided with the opportunity of a systematic inservice training. The recommendations in this section of the chapter are therefore related to the general retraining needs for primary school teachers.

The following recommendations are made:

1. For the general upgrading of primary teachers, similar systematic inservice programs in three other areas should be planned and implemented in addition to the mathematics programs. The areas include: Language (English and Yoruba), Science and Social Studies. Each of these programs lasting for a period of at least one year. Teachers should decide whether they want to participate in inservice programs in one or two subjects running concurrently during the same year.

2. The present Associateship Diploma Program offered in the State University Institute of Education at Ife (for the purpose of upgrading Grade II teachers' competencies) should be expanded to include part-time and summer courses, thereby reaching more teachers.

3. Part-time and summer credit courses should be initiated in Grade II Teachers Colleges for the untrained teachers.

4. Various aspects of primary teachers preservice training programs should be improved accordingly.

5. In the long run, inservice centers for mathematics and other subjects should be a part of each Teacher Training College in the state.

Implications for Primary Education

Lack of financial support can be a barrier to educational reform just as lack of ideas and initiative (Beeby, 1966). Even if the coordinated community resources and donations are substantial, there are still many areas of the program which will involve a considerable about of financial commitment. The preparation of instructional materials including texts and teaching aids, extensive inservice programs in urban and rural centers, and the appointment of a corps of personnel would result in a considerable amount of expenses.

The reforms in instructional approach would necessarily call for a re-examination of the present school structure and organization, if new ideas and initiative of the teachers should be successfully put into practice in the classrooms.

The following recommendations are made:

1. A generous financial support should be given to the different ventures that would be included in the implementation of the mathematics inservice model.

2. The school system of examination should be modified so that teachers can be encouraged to teach for understanding and not for the examination.

Implications for Further Research

The most direct follow-up to the present study would be to investigate the effectiveness of the various aspects of the inservice model. Since evidence showed that inservice teachers are in a receptive mood for mathematics instruction, the teacher training colleges, the universities and the

Ministry of Education should take advantage of this and provide the instruction. The study also offers opportunity for further research in the area of inservice education, mathematics education, and other related problems. Some of the identified problems for further research are listed below:

1. Field testing of the proposed inservice mathematics model.

2. Development and testing various materials of instruction for inservice mathematics education.

3. Appraisal by selected teachers of the preservice preparation and inservice mathematics education needs.

4. The role of the universities in the inservice education of primary school teachers.

5. The comparative effectiveness of different incentives for participation in inservice education programs.

6. A suggested program for equipping teachers to take up action research projects in the schools.

7. The strengths and weaknesses of correspondence courses as means of inservice mathematics education for primary school teachers.

8. The role of the community and of teachers' organizations in providing inservice education to teachers.

9. Desired qualities in the organizers of the inservice education programs.

10. The effectiveness of the different instructional approaches in mathematics (e.g., discovery, guided learning, expository, and laboratory approach) in inservice education.

11. Correlation between pupils' achievement and inservice mathematics education of the teachers.

12. Investigation into various aspects of mathematics learning and the Nigerian child, the language and other cultural factors.

APPENDICES

APPENDIX A

LIST OF ORGANIZERS and/or SPONSORS

1. Governmental Department, Educational Institutions and Professional Organizations:

    a. Research and Training Division, Ministry of Education, Western State, Ibadan.

    b. Institute of Education, University of Ibadan, Ibadan.

    c. Institute of Education, University of Ife, Ile-Ife.

    d. Mathematics Association of Nigeria, Western State Branch, Ibadan.

    e. Nigeria Union of Teachers, Western State Branch, Ibadan.

2. Governmental Officials in the State and Federal Ministries of Education:

    a. The Chief Inspector of Education, Western State Ministry of Education, Ibadan.

    b. The Chairman, Nigeria Educational Research Council, Federal Ministry of Education, Lagos.

    c. The Chief Federal Advisor on Education, Federal Ministry of Education, Lagos.

APPENDIX B

INSTRUMENTS USED IN GATHERING SURVEY DATA

Questionnaire 1: Primary Teachers' Questionnaire

Questionnaire 2: Headmasters' Questionnaire

Questionnaire 3: Organizers' and/or Sponsors' Questionnaire

Correspondence with three governmental officials.

Inservice Mathematics Education for Primary School Teachers in Western State, Nigeria.

Primary Teacher's Questionnaire

Please complete this questionnaire if:

a. you are a Grade II teacher (not pivotal), who did only "Arithmetic Process" in your Grade II Teachers College; or
b. you are a Grade III teacher.

SECTION I

In this section we would like some general information about your experience with the teaching of arithmetic. Please continue your answers to the questions at the back of the page where necessary.

1. How many years have you been teaching?____________________

2. What primary class are you presently teaching?____________________

3. What other primary class or classes have you taught?____________________

4. List the topics in arithmetic you found most difficult to teach:

____

5. Have you attended any inservice training or refresher course in mathematics or modern mathematics since you started teaching?

Yes__________; No__________

6. If No is checked, please omit no. 6 and go on to no. 7. If Yes is checked please complete the following:

a. Who offered the programme?____________________

b. How long did the programme last?____________________

c. List the main topics in mathematics that were covered in the programme:

____

d. List some of the topics that have changed some of your classroom teaching practices:

____

e. Can you tell us how these have changed your lesson?____________________

____

f. How could those who taught the programme have improved it?_______

____

7. If No is checked in answering no. 5, please complete the following:

   a. Have you heard of any inservice programme in mathematics for primary school teachers in the State?

      Yes_________; No_________

   b. If yes, who organized it?_______________________________________

   c. Where was it held?____

   d. Would you want to attend a mathematics inservice programme, if you were invited?

      Yes_________; No_________

   e. Under what conditions would you like to attend?_________________

   ____

   f. Of what importance is such a programme to you?__________________

   ____

8. Please indicate your present teaching status (Check one).

   Grade II________; Grade III________

9. Please name the town or village in which your school is located.

____

10. Are you: Male___ or Female___; Married___ or Single___

SECTION II

A. The following is a list of some subjects we teach in our primary schools. If you have a choice of teaching the subject you like best, how would you rate each of them? Put (1) in front of the subject you like to teach best; (2) in front of the next one; and so on. Number 9 is for the subject you least enjoy teaching.

English ....________
Yoruba ....________
Religious Knowledge....________
Arithmetic.............________
Hygiene................________

Nature Study..........________
Physical Education.....________
History...............________
Geography.............________

B. For each pair of items, please choose the one you would prefer to do if you have no other choice. Circle either (a.) or (b.)

1. a. Help a child with his spelling lesson.
   b. Help a child with his arithmetic problem.

2. a. Collect figures of what is happening in trade and industry
   b. Weave cloth on a hand loom

3. a. Do typing and shorthand
   b. Do work that requires mental arithmetic

4. a. Study methods of supplying maize with water
   b. Study rapid methods of solving arithmetic problems

5. a. Take a course in mathematics
   b. Take a course in English language

6. a. Be the treasurer of your local club
   b. Be the secretary of your local club

7. a. Make tables of figures on the costs of food and clothes
   b. Write compositions on your favourite games

8. a. Estimate the cost of equipment for your school
   b. Decorate the school hall for a play

SECTION III

A. The following are among the major topics included in the primary school mathematics syllabus. Many teachers, however, feel that they need more knowledge of some of the topics. Which of these topics would you like us to include in a mathematics inservice programme for primary school teachers? Check "Yes" or "No" for each topic:

	YES	NO
Base 10 numeration system..........................	( )	( )
Four basic operations with whole numbers..........	( )	( )
Common and Decimal Fractions......................	( )	( )
Four basic operations with fractions..............	( )	( )
Simple ideas of Sets..............................	( )	( )
Adding and subtracting positive and negative numbers.	( )	( )
Numeration system in bases other than 10, e.g. Base 5..	( )	( )
Factors, primes and composite numbers.............	( )	( )
Properties of points, lines and planes............	( )	( )

	YES	NO
Solid geometric figures (e.g. Cubes, Cuboids, Pyramids, Prisms, etc.)...........................	( )	( )
Idea of area and perimeter of regions............	( )	( )
Idea of symmetry.................................	( )	( )
Idea of congruence...............................	( )	( )
Metric System of measurement.....................	( )	( )
Interpreting and constructing line, circle and bar graphs...	( )	( )
Simple geometric constructions (e.g. perpendicular bisector of a line, bisector of an angle, etc.)...	( )	( )
Mean, Median and Mode............................	( )	( )
Making up and solving mathematical sentences.....	( )	( )
Solving mathematical problems....................	( )	( )
Mathematical ideas used in trade and business (e.g. discount, interest, profit and loss.)......	( )	( )
Simple idea of probability.......................	( )	( )

B. List other mathematical topics not mentioned above that you would like to learn more about in an inservice programme:

____

SECTION IV

This section deals with some of our instructional materials, methods and other classroom practices in arithmetic teaching.

A. Please tell me about your arithmetic lessons:

1. List the arithmetic textbook or textbooks your pupils use:

____

2. List by name and author any books you have used as your reference books in arithmetic teaching:

____

3. Name some of the teaching aids you have found most helpful in arithmetic teaching:

____

B. Below is listed a series of statements dealing with arithmetic teaching and related classroom practices. Please indicate the degree to which you agree with the statements by circling the number of the most appropriate response, according to the following key:

Key

1 -- I completely agree
2 -- I agree
3 -- I am uncertain
4 -- I disagree
5 -- I completely disagree

a. It is necessary to give individual help to pupils in arithmetic lessons. 1 2 3 4 5

b. I can teach arithmetic without reading teachers' guides and method books. 1 2 3 4 5

c. Arithmetic is a skill with little practical application in Nigerian life. 1 2 3 4 5

d. Pupils learn from one another so I encourage group work in my arithmetic class. 1 2 3 4 5

e. Working with arithmetic games and puzzles in the classroom can be a worthwhile activity. 1 2 3 4 5

f. Children in the class I teach are too young to discover their own rules for solving arithmetic problems. 1 2 3 4 5

g. A field trip to the market place is a valuable resource for arithmetic learning. 1 2 3 4 5

h. I assign extra arithmetic problems as homework when pupils misbehave. 1 2 3 4 5

i. Teachers should change their approach to classroom teaching to make use of some of the newer techniques and teaching ideas. 1 2 3 4 5

j. One final test at the end of term is enough to find out how well my pupils understand their arithmetic lessons. 1 2 3 4 5

SECTION V

In this section, we would like to know your needs for and your views on the organization of mathematics inservice programmes. Please put a circle around the letter for the statement that best describes your view in each case:

1. What mathematical content should be included in the programme?

   a. Content in the primary school mathematics syllabus
   b. Content that goes beyond the primary syllabus
   c. Content of both the primary and secondary school mathematics syllabi
   d. Other (explain)____________________________________

2. Should the inservice training programme deal with:
   a. Subject matter of mathematics only?
   b. Newer methods of teaching mathematics only?
   c. Subject matter and methods interwoven?
   d. Subject matter, methods and materials of instruction?
   e. Other (explain)____

3. When should inservice programmes be conducted?
   a. Three weeks during the long vacation
   b. Two weeks during the long vacation followed by a correspondence course during the school year
   c. Two weeks during the long vacation followed by a radio course during the school hours throughout the school year
   d. Three-hour sessions fortnightly throughout the school year
   e. Other (please state)____________________________________

4. Where should inservice programmes be held?
   a. In the Teacher Training College near your town
   b. In a Secondary School in your town
   c. In an Institute of Education of a University
   d. Other (please state)____________________________________

5. Should the inservice programme be made:
   a. Compulsory for all primary school teachers
   b. Optional for teachers
   c. Compulsory for some teachers, who would become qualified to be special mathematics teachers in the primary school? (They may teach some other subjects as well.)
   d. Other (explain)____

6. What kind of credits should be given for successful participation in an inservice programme?
   a. A certificate of attendance
   b. A reward towards promotion prospects
   c. A grade towards the attainment of a teaching certificate
   d. An increment in salary
   e. Other (please state)____________________________________

7. How should we decide on the effectiveness of an inservice mathematics programme?
   a. Through an evaluation of participant's understanding by giving him/her some formal and informal tests
   b. Through fromal and informal tests for the participant, and other tests for the pupils he/she teaches
   c. Through tests for participant and pupils, and through an evaluation of his/her classroom practices in teaching mathematics
   d. Other (please state)____________________________________

8. Should headmasters and school inspectors participate in the inservice programme for teachers?

   Yes________ No________

9. The following topics represent a sample of the content of inservice programmes in mathematics. Please consider your own needs for mathematics teaching and rate the topics in order. For example, put (1) in front of the topic of your greatest needs, then (2) for the next, and so on. The number 6 is for the topic you need least.

   a. Learning the subject matter of mathematics covered in the school syllabus........................... ______

   b. Setting, marking and interpreting teacher-made tests and school examinations.................... ______

   c. Planning and preparing lessons................... ______

   d. Teaching methods, aids and materials............. ______

   e. Study of child development, learning problems of pupils and methods of dealing with them........... ______

   f. Methods of dealing with large classes including pupils with varying abilities.................... ______

10. List other ideas you have for inservice activities in mathematics:

    ____

11. Please rate the following groups in order of your choice of teachers to teach you in an inservice mathematics programme. Put (1) in front of the group you would choose first as teachers, (2) for the next, and so on. The number 4 is for your last choice.

    a. School inspectors from the Ministry of Education.. ______

    b. Well-qualified secondary school teachers in your neighborhood.................................... ______

    c. Tutors from the Teacher Training College.......... ______

    d. University lecturers............................. ______

12. Which of the following will stop you from participating in an inservice mathematics programme? (Check as many as are applicable to you)

    a. Cost of transportation........................... ______
    b. Fees charged for the training programmes.......... ______
    c. Dislike of travel away from home.................. ______
    d. Family and other domestic responsibilities........ ______
    e. Inservice training not helpful................... ______
    f. Other (please state)______________________________________

13. Are you currently taking any tuition in mathematics or any other subjects for GCE O'Level? Yes________ No________

14. Do you have any teaching method that you have successfully used in arithmetic and would like to share with other teachers in an inservice programme? Explain briefly:______________________________________

    ____

15. Please feel free to add any additional comments you may have on in-service mathematics programmes below. (use the back of this page, if necessary.)____

____

16. If you are interested in receiving a summary of this questionnaire result, please indicate your name and a permanent address at which you can be reached.

Name:____

Address:____

THANK YOU VERY MUCH. WE SINCERELY APPRECIATE YOUR HELP AND HOPE WE CAN OFFER YOU BETTER SERVICE IN FUTURE TOWARDS QUALITY EDUCATION IN OUR PRIMARY SCHOOLS.

Inservice Mathematics Education for Primary School Teachers in Western State, Nigeria.

Headmasters' Questionnaire

SECTION I

1. How many teachers are there in your school?________________________

2. Please indicate the number of teachers in each of the following groups:

   a. Grade II:__________________________

   b. Grade III:_________________________

   c. No teaching qualification:__________

   d. Others:____________________________

3. How many years have you been headmaster in this school?____________

4. How many of your teachers have participated in an inservice mathematics programme for primary school teachers since you have headed the school?

   ____

5. Please name your District Headquarter:______________________________

6. How far is your school from this Headquarter? (Check one.)

   _______ Less than 50 miles

   _______ Between 50 and 100 miles

   _______ More than 100 miles

7. How far is your school from the nearest Teacher Training College: (Check one.)

   _______ Less than 50 miles

   _______ Between 50 and 100 miles

   _______ More than 100 miles

8. Is there a radio or a rediffusion in your school?

   Yes_________; No_________

9. What are some of the problems you have with arithmetic teaching in your school?____

   ____

10. How can the Institute of Education at Ife be of most help to you and your teachers with these problems?____________________________

    ____

11. How can the State Ministry of Education be of most help to you and your teachers with these problems?__________________________________

    ____

SECTION II

We would like to know your views on the organization of inservice mathematics programmes for primary school teachers. Please put a circle around the letter that best describes your view in each case:

1. What mathematical content should be included in the programme?
   a. Content in the primary school mathematics syllabus
   b. Content that goes beyond the primary syllabus
   c. Content of both the primary and secondary school mathematics syllabi
   d. Other (please explain)________________________________

2. Should the inservice training programme deal with:
   a. Subject matter of mathematics only?
   b. Newer methods of teaching mathematics only?
   c. Subject matter and methods interwoven?
   d. Subject matter, methods and materials of instruction?
   e. Other (please state)________________________________

3. When should the inservice programme be conducted?
   a. Three weeks during the long vacation
   b. Two weeks during the long vacation followed by a correspondence course during the school year
   c. Two weeks during the long vacation followed by a radio course during the school hours throughout the year.
   d. Three-hour sessions fortnightly throughout the school year
   e. Other (please state)________________________________

4. Where should the inservice programme be held?
   a. In the Teacher Training College near your town
   b. In a Secondary School in your town
   c. In an Institute of Education of a University
   d. Other (explain)________________________________

5. Should the inservice programme be made:
   a. Compulsory for all primary school teachers?
   b. Optional for teachers?
   c. Compulsory for selected teachers, who would become special mathematics teachers in the primary schools? (They may teach some other subjects as well.)
   d. Other (explain)________________________________

6. What kind of credits should be given for successful participation in the inservice programme?
   a. A certificate of attendance
   b. A reward towards promotion prospects
   c. A grade towards the attainment of a teaching certificate
   d. An increment in salary
   e. Other (please state)________________________________

7. How should we decide on the effectiveness of inservice mathematics programme?

   a. Through an evaluation of participant's understanding by giving him/her some formal and informal tests
   b. Through formal and informal tests for the participant, and other tests for the pupils he/she teaches
   c. Through tests for participant and pupils, and through an evaluation of his/her classroom practices in teaching mathematics.
   d. Other (please state)____________________

8. Should headmasters and school inspectors participate in the inservice programme for teachers? Yes________; No________

9. Please feel free to add any additional comments you may have on inservice mathematics programmes below. (Use the back of this page, if necessary.)____________________

10. Please indicate your name and a permanent address at which you can be reached, if you so desire:

    Name:____________________

    Address:____________________

THANK YOU VERY MUCH. WE SINCERELY APPRECIATE YOUR HELP AND HOPE WE CAN OFFER YOU BETTER SERVICE IN FUTURE TOWARDS QUALITY EDUCATION IN OUR PRIMARY SCHOOLS.

Inservice Mathematics Education for Primary School
Teachers in Western State, Nigeria

Questionnaire for Organizers or Sponsors of Inservice Training

Please respond to each question as fully as possible. Continue at the back of the page, if desired.

SECTION I

1. Please list the programme of inservice mathematics training that have been offered to Primary School Teachers by your institution/organization. In each case, indicate the time, duration of programme, place and number of participants.

   a)

   b)

   c)

2. What do you consider to be the most important contribution of these inservice programmes to the primary schools?

   ____

   ____

3. How could the programmes be improved for maximum benefit to the teachers and the primary schools?

   ____

   ____

4. What are some of your future plans for inservice mathematics training of primary school teachers?

   ____

   ____

   Questions 5 and 6 in this section are for the Research and Training Division of Ministry of Education, Western State, only:

5. In your opinion about what percentage of the primary teachers in the state would need the upgrading of their mathematical background in order to teach the content of the proposed syllabus for primary school adequately.

   (Check one)

   (a) Below 25%.............._____
   (b) Between 25% and 50%....._____
   (c) 50% and above..........._____
   (d) Other (please state)...._____

6. Please indicate the number of Teacher Training Colleges in Western State that presented candidates for each of these alternative compulsory papers in June, 1974 Grade II Teachers' Examination:

a) Arithmetic Process and Method Papers, No. of Colleges:

____

b) Basic Mathematics and Method Papers, No. of Colleges:

____

SECTION II

In this section we sould like to know your views on the organization of inservice mathematics. Please put a circle around the letter that best describes your view in each case.

1. What mathematical content should be included in the programme?

   a. Content in the primary school mathematics syllabus
   b. Content that goes beyond the primary syllabus
   c. Content of both the primary and secondary school mathematics syllabi
   d. Other (please explain)______________________________

2. Should the inservice training programme deal with:

   a. Subject matter of mathematics only?
   b. Newer methods of teaching mathematics only?
   c. Subject matter and methods interwoven?
   d. Subject matter, methods and materials of instruction?
   e. Other (please state)______________________________

3. When should inservice training be conducted?

   a. Three weeks during the long vacation
   b. Two weeks during the long vacation followed by a correspondence course during the year
   c. Two weeks during the long vacation followed by a radio course during the school hours throughout the year
   d. Three-hour sessions fortnightly throughout the school year
   e. Other (please state)______________________________

4. Where should inservice programme be held?

   a. In the Teacher Training College near the teacher's town (where he teaches)
   b. In a Secondary School in the town where he teaches
   c. In an Institute of Education of a University
   d. Other (explain)______________________________

5. Should the inservice programme be made:

   a. Compulsory for all primary school teachers?
   b. Optional for teachers?
   c. Compulsory for selected teachers, who would become special mathematics teachers in the primary schools? (They may teach some other subjects as well.)
   d. Other (explain)______________________________

6. What kind of credits should be given for successful participation in the inservice programme?

   a. A certificate of attendance
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   c. A grade towards the attainment of a teaching certificate
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   e. Other (please state)____________________________________

7. How should we decide on the effectiveness of inservice mathematics programme?

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   b. Through formal and informal tests for the participant, and other tests for the pupils he/she teaches
   c. Through tests for participant and pupils, and through an evaluation of his/her classroom practices in the teaching of mathematics
   d. Other (please state)____________________________________

8. Should headmasters and school inspectors participate in the inservice programme for teachers?

   Yes_________; No_________

9. What is the feasibility of using any mass media for a follow-up of inservice programme for primary teachers in your opinion?

   ____

   ____

10. Please feel free to add any additional comments you may have on inservice mathematics programmes below. (Use the back of this page, if necessary.)____________________________________

    ____

11. If you would like a brief summary of this survey, please indicate your name and address below:

    Name:____

    Address:____

THANK YOU FOR YOUR ASSISTANCE.
I SINCERELY APPRECIATE YOUR HELP
AND HOPE WE CAN CONTINUE TO WORK
TOGETHER TOWARDS QUALITY EDUCATION
IN OUR PRIMARY SCHOOLS.

557 West Owen Hall
Michigan State University
East Lansing, Michigan 48824
U.S.A.
December 27, 1974.

The Chief Inspector of Education
Western State of Nigeria
c/o. The Ministry of Education,
Ibadan, Nigeria.

Dear Sir/Madam,

In partial fulfilment of a doctoral degree programme in Elementary Education, with emphasis on mathematics and teacher training, I am conducting a survey on inservice mathematics education for primary school teachers in Western State, Nigeria. I plan to develop a model for a systematic inservice mathematics education for primary school teachers based on the findings of the survey, the basic mathematics knowledge required of elementary teachers -- based particularly on the content of the proposed primary mathematics syllabus for Western State schools, the available facilities for such re-education, and on research findings related to the learner and to mathematics learning.

The need for a systematic inservice training for primary school teachers, particularly in the area of mathematics and science has been frequently echoed in our society. The Nigerian National Education Research Council at its workshop of 1971 gave recommendations as to the need for the re-education of teachers in order that they may teach the new concepts and ideas proposed in the new curriculum adequately.

At the invitation of the Nigerian Federal Ministry of Education, through the British Council, Mr. B.J. Wilson of CEDO, London, visited Nigeria in 1971 for the purpose of studying the state of mathematics teaching in Nigeria. Although his study was to centre on secondary schools, he found it necessary to examine the situation in both the primary schools and the teacher training colleges as well, as stated in his report. Among his recommendations was that permanent inservice centres under the Ministries be established whereever possible.

No doubt the different Western State Primary School Curriculum Panels, including the mathematics panel, might also have implications for inservice training in their recommendations. The implementation of the new curriculum calls for a significant and systematic inservice training of teachers. Furthermore, it seems imperative that while we are working hard at the problems of an expanding primary education system, we should upkeep the quality of the system at the same time. Since quality education depends very much on the quality of our teachers, a continuing inservice training seems to be a necessity.

It is with these instances in mind that I am humbly soliciting your comments on inservice mathematics training for the primary school teachers. I would especially appreciate your comments on the following and any other issue related to inservice mathematics training:

a. Existing programmes and/or future plans aimed at upgrading teachers' inadequate background for the implementation of the new curriculum;

b. The possibilities of granting incentives to teachers for successful participation in the inservice training programs;

c. The use of the mass media for inservice training of primary teachers.

I would like to ask for your permission to quote you in my writing, if necessary, and would greatly appreciate your response to this letter on or before the end of January, 1975.

While I await to hear from you, I thank you in advance.

Respectfully yours,

B. Mabogunje Osibodu (Mrs.)
Faculty of Education
University of Ife, Nigeria.
(Currently on study-leave at
Michigan State University, USA.)

557 West Owen Hall
Michigan State University
East Lansing, Michigan 48824
U.S.A.
December 27, 1974.

The Chief Federal Advisor of Education
c/o The Federal Ministry of Education
Lagos, Nigeria

Dear Sir,

In partial fulfilment of a doctoral degree programme in Elementary Education, with emphasis on mathematics and teacher training, I am conducting a survey on inservice mathematics education for primary school teachers in Western State, Nigeria. I plan to develop a model for a systematic inservice mathematics programs for primary school teachers based on the findings the survey, the requirement of the new syllabus -- in particular the Nigeria Educational Research Council (NERC) guidelines, the available facilities for such re-education, and on research findings related to the learner and to mathematics learning. Although my survey is limited to sample of teachers from selected towns and villages of Western State, it is hoped that the findings can be generalized to other states, to some extent at least, and that the model will be applicable in other parts of the country.

The need for a systematic inservice training for primary school teachers, particularly in the area of mathematics and science has been frequently echoed in our society. The NERC at its curriculum workshop in 1971 gave recommendations as to the need for the re-education of teachers in order that they may adequately teach the new concepts and ideas proposed in the new curriculum.

At the invitation of the Nigerian Federal Ministry of Education, through the British Council, Mr. B.J. Wilson of CEDO, London visited Nigeria in 1971 for the purpose of studying the state of mathematics teaching in Nigeria. Although his study was to centre on secondary schools, he found it necessary to examine the situation in both the primary schools and the teacher training colleges as well, as stated in his report.* Among his recommendations was that permanent inservice centres under the Ministries be established whereever possible.

These two instances reaffirm, very encouragingly, the interest and concern of the Federal Government in the teaching of mathematics in Nigerian schools. It is with this in mind that I am humbly soliciting your comments on Inservice Mathematics training for primary teachers.

*The report was presented to the professional division of the Federal Ministry of Education in June, 1971, and a copy was sent to the Mathematics Association of Nigeria, while I was a Council member of that organization.

I do realise that different states have plans for the organization of their primary schools. It seems, however, that the problems of mathematics and science teaching at the foundation stage is such a great task that calls for the coordination and aid of the federal government.

Again while we are working hard as a nation on the call and problems of quantity in primary education, it seems imperative for us to upkeep quality at the same time. The quality of our primary schools depends on our primary teachers. Some attempts are already being made toward better preservice training of new teachers in this subject area. It seems, however, that there is a definite need to retrain and upgrade the levels of the thousands of primary teachers whose basic education is inadequate for the demands that the curriculum of the 1970's are making on them. I would, therefore, appreciate receiving from you some statements or comments regarding the Federal Government plans and/or policies toward the inservice training of primary school teachers. This statement may be specifically in relation to mathematics teaching, or the teaching of mathematics and science, or to the teaching of the curriculum as a whole. It may also be in terms of aids planned or given to the states. I would like to ask for your permission to quote you freely in my writing, where necessary and would greatly appreciate your response to this letter on or before the end of January, 1975, as I am planning to complete the project around June, 1975.

While I await to hear from you, I thank you in advance.

Respectfully yours,

B. Mabogunje Osibodu (Mrs.)
Faculty of Education,
University of Ife, Nigeria.
(Currently on study-leave at
Michigan State University, USA.)

557 West Owen Hall
Michigan State Univeristy
East Lansing, Michigan 48824
U.S.A.
December 27, 1974.

The Chairman,
Nigeria Educational Research Council (NERC)
P. O. Box 8058
Lagos, Nigeria.

Dear Sir,

In partial fulfilment of a degree programme in Elementary Education, with emphasis on mathematics and teacher training, I am conducting a survey on inservice mathematics education for primary school teachers. I plan to develop a model for a systematic inservice mathematics education based on the findings of the survey, the requirement of the new mathematics curriculum -- in particular the Nigeria Educational Research Council guidelines on Teacher Training mathematics curriculum -- and on research findings on the learner and the learning of mathematics. Although my survey is primarily based in the Western State of Nigeria, it is hoped that the proposed model will be generally applicable in other parts of the nation.

As a national education body, the NERC has done great work in producing new curriculum guidelines for the nation's schools. These attempts toward curriculum improvement in the schools are praise worthy. However, a crucial factor affecting curriculum change so deeply is the capacities of the teachers. Discussions and recommendations from the different NERC curriculum workshops have emphasized the need for better preservice and inservice training, in particular, for the primary school teachers.

My purpose of writing this letter to you is to humbly solicit your comments and/or plans on inservice mathematics training for primary school teachers. This may be in terms of inservice training for mathematics alone, for mathematics and science, or for mathematics and some other subjects. I would especially appreciate your comments on the following and any other issue related to inservice training:

a. Existing programmes and/or future plans aimed at upgrading primary teachers with inadequate background knowledge for the implementation of the new curriculum;

b. Any plan to coordinate programmes of inservice mathematics or mathematics and other related subjects on the nation-wide basis.

I would like to ask for your permission to make reference to your comments in my writing, if need be, and would greatly appreciate your response to this letter on or before January ending, 1975.

While I thank you in advance,

I remain,

Yours respectfully,

B. Mabogunje Osibodu (Mrs.)
Faculty of Education
University of Ife, Nigeria
(Currently of study-leave at
Michigan State University,
U.S.A.)

APPENDIX C

List of Towns in Which Participating Schools are located by Classification.

Urban Towns*

Ibadan	Okitipupa
Abeokuta	Ijebu-Ode
Ilaro	Sagamu
Ado-Ekiti	Ile-Ife
Ikole-Ekiti	Ilesha
Ijero-Ekiti	Oshogbo
Akure	Oyo
Owo	Ogbomosho
Ondo	Shaki

Rural Towns

Fiditi	Yekemi (via Ondo)
Ikereku	Ode-Aye
Itapa-Ekiti	Oru-Awa
Ilupeju-Ekiti	Osu-Ilesha
Iju-Akure	Edunabon
Bagbe-Ondo	Ago-Are.

*The terms "urban" and "rural" in this classification are used as follows: A divisional headquarter is termed urban, while small towns and villages are classified as rural.

APPENDIX D

TEST OF BASIC MATHEMATICAL UNDERSTANDINGS*

Form A (Pre-test) and Form B (Post-test)

Directions:

This test is designed to measure your understanding of mathematics. Many of the items relate to the content in present programs of mathematics of elementary pupils.

Each of the fifty questions is of multiple-choice type and includes four possible answers. Read each question carefully and decide which answer fulfills the requirements of the statement. Then circle the response on the answer sheet to indicate your choice.

Circle only one answer for each question. If you change your choice, erase your original mark and circle the correct one.

Sample Question:

1. Which of the following shows the decimal form of the fraction 5/4?

a. 125	b. 12.5
b. 1.25	d. .125

Answer Sheet:

1. a b c d

Since 1.25 is the correct answer, the letter (c) is circled.

*The original Test of Basic Mathematics Understandings was prepared by Dr. Mildred Jerline Dossett, Michigan State University, East Lansing, Michigan, 1964. (See Bibliographic listing under the name, Dossett, for reference).

The revised form of the test presented here is adapted for use in this study by the investigator.

FORM A (PRE-TEST)

1. When you write the numeral "5" you are writing

   a. the number 5
   b. a pictorial expression
   c. a symbol that stands for an idea
   d. a Hindu-Babylonian symbol

2. Bola discovered the > means "is greater than" and < means "is less than." In which of the following are these symbols not used correctly?

   a. The number of states in Nigeria < the number of states' capitals.
   b. $3 + a < 5 + a$
   c. $3^3 > 4^2$
   d. The number of teachers in the school < the number of pupils in the school.

3. When two Roman numerals stand side by side in a symbol, their values are added.

   a. always
   b. sometimes
   c. never
   d. if the base is X

4. Zero may be used

   a. as a place holder
   b. as a point of origin
   c. to represent the absence of quantity
   d. in all of the above different ways

5. 2,200.02 is shown by

   a. 2000 + 200 + 20
   b. 2000 + 20 + 2/10
   c. 2000 + 200 + 2/100
   d. 2000 + 200 + 200

6. 5840 rearranged so that the 8 is 200 times the size of 4 would be

   a. 5840
   b. 8540
   c. 5048
   d. 5408

7. Which of the following does not show the meaning of 423_{ten}?

   a. (4 x 100) + (2 x 10) + 3(1) = 423
   b. 42 tens + 3 ones = 423
   c. 423 ones = 423
   d. 4 hundreds + 42 tens + 23 ones = 423

8. A "2" in the third place of a base five number would represent

   a. 2×5^2
   b. 5×2^3
   c. 5×2^5
   d. 2×5^3

9. In this addition example, in what base are the numerals written?

   a. base two
   b. base three
   c. base four
   d. none of the above

$$\begin{array}{r} 120_? \\ +10_? \\ \hline 200_? \end{array}$$

10. About how many tens are there in 6542?

    a. 6540
    b. 654
    c. 65½
    d. 6.5

11. Place or order in a series is shown by

    a. book no. 7
    b. three boxes of matches
    c. a dozen cupcakes
    d. two months

12. Which of the following indicates a group?

    a. 45 tickets
    b. track 45
    c. page 54
    d. house no. 7

13. The sum of any two natural numbers

    a. is not a natural number
    b. is sometimes a natural number
    c. is always a natural number
    d. is a natural number equal to one of the numbers being added

14. The counting numbers are closed under the operations of

    a. addition and subtraction
    b. addition and multiplication
    c. addition, subtraction, multiplication and division
    d. addition, subtraction, and multiplication

15. If a and b are natural numbers, then a + b = b + a is an example of

    a. commutative property
    b. associative property
    c. distributive property
    d. closure

16. If a x b = 0 then

    a. a must be zero
    b. b must be zero
    c. either a or b must be zero
    d. neither a nor b must be zero

17. When a natural number is multiplied by a natural number other than 1, how does the answer compare with the natural number multiplied?

    a. larger
    b. smaller
    c. the same
    d. can't tell from information given

18. Which of the following is the quickest way to find the sum of several numbers of the same size?

    a. counting
    b. adding
    c. subtracting
    d. multiplication

19. How would the product in this example be affected if you put the 29 above the 4306 and multiplied the two numbers?

    $$\begin{array}{r} 4306 \\ \underline{\times 29} \end{array}$$

    a. The answer would be larger
    b. The answer would be smaller
    c. You cannot tell until you multiply both ways
    d. The answer would be the same

20. The product of 356 x 7 is equal to

    a. (300 x 50) x (6 + 7)
    b. (3 x 7) + (5 x 7) + (6 x 7)
    c. 300 x 50 x 6 x 7
    d. (300 x 7) + (50 x 7) + (6 x 7)

21. Which of the following is <u>not</u> a prime number?

    a. 271
    b. 277
    c. 281
    d. 282

22. Which of the following numbers is odd?

    a. 18 x 11
    b. 11 x 20
    c. 99 x 77
    d. none of the above

23. The inverse operation generally used to check multiplication is

    a. addition
    b. subtraction
    c. multiplication
    d. division

24. The greatest common factor of 48 and 60 is

    a. 2 x 3
    b. 2 x 2 x 3
    c. 2 x 2 x 2 x 2 x 3 x 5
    d. none of the above

25. Look at the example at the right. Why is the "4" in the third partial product moved over two places and written under the 2 of the multiplier?

$$\begin{array}{r} 157 \\ \underline{\times 246} \\ 942 \\ 628 \\ \underline{314} \end{array}$$

a. If you put it directly under the other partial products, the answer would be wrong.
b. You must move the third partial product two places to the left because there are three numbers in the multiplier.
c. The number 2 is the hundreds column, so the third partial product must come under the hundreds column.
d. You are really multiplying by 200.

26. Which of the fundamental properties of arithmetic would you employ in showing that (a + b) + (a + c) = 2a + b + c?

a. associative property
b. commutative property
c. associative and distributive properties
d. associative and commutative properties

27. If N represents an even number, the next larger even number can be represented by

a. N + 1
b. N + 2
c. N + N
d. 2 x N + L

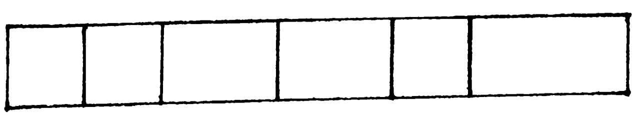
28. Every natural number has at least the following factors:

a. zero and one
b. zero and itself
c. one and itself
d. itself and two

29. It is said that the set of whole numbers has a natural order. To find the successor of a natural number, one must

a. add 1
b. find a number that is greater
c. square the natural number
d. subtract 1 from the natural number

30. The paper below has been divided into 6 pieces. It shows



a. sixths
b. thirds
c. halves
d. parts

31. A fraction may be interpreted as:

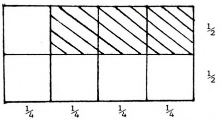
a. a quotient of two natural numbers
b. equal part/parts of a whole
c. a comparison between two numbers
d. all of the above

32. When a common (proper) fraction is divided by a common (proper) fraction, how does the answer compare with the fraction divided?

    a. it will be larger
    b. it will be smaller
    c. it will be twice as large
    d. there will be no difference

33. Which algorithm is illustrated by the following sketch?

    a. 1/2 x 3/4 = ?
    b. 1/2 + 3/3 + ?
    c. 1/4 + 1/4 + 1/4 = ?
    d. 4/4 - 3/2 = ?



34. Another name for the inverse for multiplication of a rational number is the

    a. reciprocal
    b. opposite
    c. reverse
    d. zero

35. Examine the division example on the right. Which sentence best tells why the answer is larger than 5? $5 \div 3/4 = 6\ 2/3$

    a. Inverting the divisor turned the 3/4 upside down.
    b. Multiplying always makes the answer larger.
    c. The divisor 3/4 is less than 1.
    d. Dividing by proper fractions makes the answer larger than the number divided.

36. The value of a common fraction will not be changed of

    a. We add the same number to both terms.
    b. We multiply one term and divide the other term by that same number
    c. We subtract the same amount from both terms.
    d. We multiply both terms by the same number.

37. The nearest to 45% is

    a. 44 out of 100
    b. .435
    c. 4.5
    d. .405

38. Sola completed 2/3 of the story in 12 minutes. At that rate how long will it take her to read the entire story?

    a. 18 minutes
    b. 12 minutes
    c. 6 minutes
    d. 24 minutes

39. There were 400 students in the school. One hundred percent of the children had lunch in the dining hall on the first day of school. On the second day 2 boys were absent and 88 children went home for lunch. Which of the following sentences can be used to find the percent of the school enrollment who went home for lunch?

 a. $400 - 88 = X$
 b. $x/100 = 88/400$
 c. $x/88 = 400$
 d. $400 - 90 = X$

40. What can be said about y in the following open sentence if x is a natural number? $x + x + 1 = y$

 a. $x < y$
 b. $x > y$
 c. $x = y$
 d. $x \neq y$

41. Which one of the following fractions will give a repeating decimal?

 a. 1/2
 b. 3/4
 c. 5/8
 d. 6/11

42. Which of the following is <u>not</u> an open sentence?

 a. $7 + 2 = \square$
 b. $h - 5 = 9$
 c. $c/1 - 30 = 6$
 d. $n - 3$

43. For a mathematical system consisting of the set of odd numbers and the operation of multiplication.

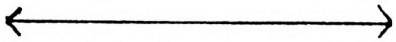
 a. the system is closed
 b. the system is commutative
 c. the system has an identity element
 d. all of the above are correct

44. Measurement is a process which

 a. compares an object with some known standard or accepted unit
 b. tries to find the exact amount
 c. is always an exact measure
 d. chooses a unit and then gives a number which tells how many of that unit it would take

  1. a and b are correct
  2. a and c are correct
  3. a, b, and d are correct
  4. a, c, and d are correct

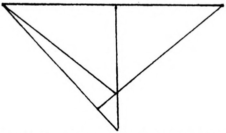
45. The set of points sketched below represents a



a. line
b. ray
c. line segment
d. none of the above

46. How many triangles does the figure contain?

a. four
b. six
c. eight
d. ten



47. The set of points on two rays with a common end-point is called

a. a triangle
b. an angle
c. a vertex
d. a side of a triangle

48. If a circle is drawn with the points of a compass 6 cm. apart, what would be 6 cm. in length?

a. circumference
b. diameter
c. area
d. radius

49. The solution set of an open sentence consists of

a. two or more numbers
b. no numbers
c. only one number
d. any or all of these

50. Consider a set of three objects. How many sub-sets or groups can be arranged?

a. nine
b. eight
c. seven
d. six

FORM B (POST-TEST)

1. When we use the = symbol between two terms (as 2 + 2 = 4), we mean that both terms represent the same concept or idea. Which of the following is not correctly stated?

   a. 3 + 4 = 5 + 2
   b. 5 + 2 = 7 and 7 = 5 + 2
   c. (5 + 2) x 3 = 7 x 3
   d. 7 = 7

      1. a and b are correct
      2. a and c are correct
      3. a, b, and c are correct
      4. a, b, c, and d are correct

2. Which of the following does not describe a characteristic of our decimal system of numeration?

   a. It uses zero to keep position when there is an absence of value.
   b. It makes a ten a standard group for the organization of all numbers larger than nine.
   c. It makes 12 the basis for organizing numbers larger than eleven.
   d. It uses the additive concept in representing a number of several digits.

3. In the numeral 7,843, how does the value of the 4 compare with the value of the 8?

   a. 2 times as great
   b. 1/2 as great
   c. 1/10 as great
   d. 1/20 as great

4. In the numeral 6,666 the value of the 6 on the extreme left as compared with the 6 on the extreme right is

   a. 6,000 times as great
   b. 1,000 times as great
   c. the same since both are sixes
   d. six times as much

5. Below are four numerals written in expanded notation. Which one is not written correctly?

   a. $4(\text{ten})^2 + 9(\text{ten})^1 + 3(\text{ones}) = 493_{\text{ten}}$
   b. $3(\text{seven})^3 + 6(\text{seven})^1 + 1(\text{one}) = 361_{\text{seven}}$
   c. $2(\text{three})^2 + 2(\text{three})^1 + 1(\text{one}) = 221_{\text{three}}$
   d. $2(\text{five})^2 + 3(\text{five})^1 + 4(\text{ones}) = 234_{\text{five}}$

6. About how many hundreds are there in 34,870?

   a. $3\frac{1}{2}$
   b. 35
   c. 350
   d. 3,500

7. If you are permitted to use any or all of the symbols 0, 1, 2, 3, 4, and 5 for developing a system of numeration with a place value system of numeration similar to ours, a list of all possible bases would include:

   a. base one, two, three, four, five, and six.
   b. base two, three, four, five, and six.
   c. base two, three, four, and five.
   d. base one, two, three, four, and five.

8. In what base are the numerals in this multiplication example written?

   a. base five
   b. base eight
   c. base eleven
   d. you can't tell

$$\begin{array}{r} 34_? \\ 23_? \\ \hline 124_? \\ 70_? \\ \hline 1024_? \end{array}$$

9. Which of the following are correct?

   a. In the symbol 5^3, 5 is the base and 3 is the exponent.
   b. In the symbol 5^3, 3 is the base and 5 is the exponent.
   c. $5^3 = 5 \times 5 \times 5$
   d. $5^3 = 3 \times 3 \times 3 \times 3 \times 3$

      1. a and d are correct
      2. b and c are correct
      3. a and c are correct
      4. b and d are correct

10. Examine the following illustration:

    1 2 3 4 5 6

    Which of the following does the above best illustrate?

    a. The idea of a cardinal number.
    b. The use of an ordinal number.
    c. A means for determining the cardinal number of the set by counting.
    d. None of the above.

11. The integers are closed under the operations of

    a. addition
    b. subtraction
    c. multiplication
    d. division

       1. a and b are correct
       2. a and c are correct
       3. a, b, and c are correct
       4. a, b, c, and d are correct

12. A student solved this example by adding down; then he checked his work by adding up.

Add ↓	34		34
	52	↑	52
	86	Check	86

It could be classified as an example of

a. the distributive principle
b. the associative principle
c. the commutative principle
d. the law of compensation

13. The statement "the quotient obtained when zero is divided by a number is zero" is expressed as

a. $a/0 = 0$
b. $0/a = 0$
c. $0/0 = a$
d. $a/a = 0$

14. When a natural number is divided by a natural number other than 1, how does the answer compare with the natural number divided?

a. larger
b. smaller
c. one-half as large
d. can't tell from information given

15. If you had a bag of 350 walnuts to be shared equally by 5 boys, which would be the quickest way to determine each boy's share?

a. counting
b. adding
c. subtracting
d. dividing

16. If the multiplier is x, the largest possible number to carry is

a. x
b. $x + 1$
c. 0
d. $x - 1$

17. Which of the following methods could be used to find the answer to this example?

$$17 \overline{)612}$$

a. Multiply 17 by the quotient
b. Add 17 six hundred times
c. The answer would be the sum
d. Subtract 17 from 612 as many times as possible. The answer would be the number of times you were able to subtract.

18. Which one of the following would give the correct answer to this example?

$$\begin{array}{r} 2.1 \\ \underline{\times 21} \end{array}$$

a. The sum of 1 x 2.1 and 21 x 2.1
b. The sum of 10 x 2.1 and 2 x 2.1
c. The sum of 1 x 2.1 and 20 x 2.1
d. The sum of 1 x 2.1 and 2 x 2.1

19. Which would give the correct answer to 439 x 563?

a. Multiply 439 x 3, 439 x 60, 439 x 5 and then add the answer.
b. Multiply 563 x 9, 563 x 3, 563 x 4 and then add the answer.
c. Multiply 563 x 9, 563 x 39, 563 x 439 and then add the answer.
d. Multiply 439 x 3, 439 x 60, 439 x 500 and then add the answer.

20. Which of these numerals are names for prime numbers?

a. 3
b. 4/2
c. 12_{five}
d. 9 - 2

1. a is correct
2. a and c are correct
3. a, b, and d are correct
4. a, b, c, and d are correct

21. Let x represent an odd number; let y represent an even number. Then x + y must represent.

a. an even number
b. a prime number
c. an odd number
d. a composite number

22. The inverse operation for addition is

a. addition
b. subtraction
c. multiplication
d. division

23. The least common multiple of 8, 12, and 20 is

a. 2 x 2
b. 2 x 3 x 5
c. 2 x 2 x 2 x 3 x 5
d. 2 x 2 x 2 x 2 x 2 x 2 x 2 x 3 x 5

24. Which statement best tells why we carry 2 from the second column?

$$\begin{array}{r} 251 \\ 161 \\ 252 \\ \underline{271} \end{array}$$

a. If we do not carry the 2, the answer would be 20 less than the correct answer.
b. Since the sum of the second column is more than 20, we put the 2 in the next column.
c. Since the sum of the second column is 23 (which has two figures in it), we have room for the 3 only, so we put 2 in the next column.
d. Since the value represented by the figures in the second column is more than 9 tens, we must put the hundreds in the next column.

25. Which of the following is an even number?

a. $(100)_{\text{three}}$
b. $(100)_{\text{five}}$
c. $(100)_{\text{seven}}$
d. $(200)_{\text{five}}$

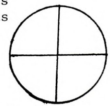
26. The fact that a + (b + c) is exactly equal to (c + b) + a is an example of

a. distributivity
b. commutativity
c. closure
d. associativity

27. Observe the drawing on the right. When the circle is cut into equal pieces, the size of each piece

a. decreases as the number of pieces increases
b. increases as the number of pieces decreases
c. increases as the number of pieces increases
d. decreases as the number of pieces decreases

1. a and b are correct
2. a and c are correct
3. b and c are correct
4. b and d are correct



28. The symbol 3/4 may be used to represent the idea that

a. 3 is to be divided by 4
b. 3 of the 4 equal parts are being considered
c. 3 objects are to be compared with 4 objects
d. all of the above

29. When a whole number is multiplied by a common (proper) fraction other than one, how does the answer compare with the whole number?

a. it will be larger
b. it will be smaller
c. there will be no difference
d. you are not able to tell

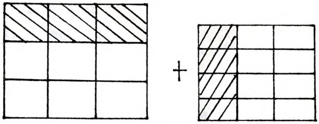
30. Which of the addition examples is best represented by the shaded parts of the diagram below?

a. 1/2 + 1/3

b. 2/3 + 3/4

c. 2/3 + 1/4

d. 1/3 + 1/3



31. We can change the denominator of the fraction $\frac{\frac{2}{3}}{\frac{4}{5}}$ to the number "1" without changing the values of the fraction by

a. adding 5/4 to the numerator and denominator
b. subtracting 5/4 from the numerator and the denominator
c. multiplying both the numerator and the denominator by 5/4
d. dividing the numerator and the denominator by 5/4

32. What statement best tells why we "invert the divisor and multiply" when dividing a fraction by a fraction?

a. It is an easy method of finding a common denominator and arranging the numerators in multiplication form.
b. It is an easy method for dividing the denominators and multiplying the numerators of the two fractions.
c. It is a quick, easy, and accurate method of arranging two fractions in multiplication form.
d. Dividing by a fraction is the same as multiplying by the reciprocal of the fraction.

33. If the denominator of the fraction 2/3 is multiplied by 2, the value of the resulting fraction will be

a. half as large
b. double in value
c. unchanged in value
d. a new symbol for the same number

34. 45% may also be written as

a. .45
b. 45/100
c. 45 x 100%
d. .450

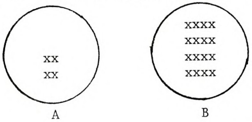
1. a and ba are correct
2. a and c are correct
3. a and d are correct
4. a, b, and d are correct

35. .5 and .27 are illustrations of "decimal fractions." They could be written as "common fractions" in the form of 1/2 and 27/100, respectively. What is a decimal fraction?

   a. It is another way of writing percentage.
   b. It is an extension of the decimal number system to the right of one's place.
   c. A number like .37½ which has both a decimal and a fraction as parts of it.
   d. A number like .2/.56 which is a fraction and has a decimal as either the numerator or denominator or both.

36. The ratio of x's in Circle A to x's in Circle B can be shown by

   a. 16/4
   b. 1/4
   c. 1/2
   d. 4/16



37. Olu paid 20k for 4 oranges. Which of the sentences below could be used to find the cost of 1 orange?

   a. 4/20 = 1/x
   b. x + 4 = 20
   c. x/4 = 20
   d. x - 4 = 20

38. Which of the following statements is <u>not</u> correct?

   a. (-9) + 6 = -3
   b. (-5) + (-5) = -10
   c. -8 + 0 = -8
   d. (-8) + (9) = -1

39. Which of the following is a list of all of the factors of 12?

   a. 1, 2, 3, 4, 8 & 12
   b. 1, 2, 3, 4, 6 & 12
   c. 1, 2, 3, 4, & 6
   d. 2, 3, 4, 6 & 12

40. Which of the following is an approximate measure?

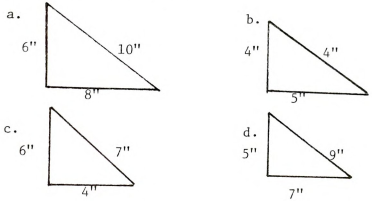
   a. 35 farms
   b. 12 buttons
   c. 7½ meters
   d. 15 beads

41. Which of the following does the sketch below represent?

a. line
b. ray
c. line segment
d. set of points

1. a is correct
2. a, b, and d are correct
3. a, c, and d are correct
4. b and d are correct

42. Which of these triangles are right triangles according to the lengths of the sides given?



43. A distinct point is

a. a point you can see
b. a sharp object
c. the intersection of two lines
d. a dot

44. A woman bought a round mat that had a radius 120 cm. Which of the formulas can she use to determine the length around the mat?

a. $A = \pi r$
b. $C = \pi d$
c. $C = 2\pi r$
d. $A = C/d$

45. Which of the following best defines a solution set?

a. A solution set is a set which includes each and every member that gives a true statement.
b. A solution set is a single sentence which identifies a variable that will give a true statement.
c. A solution set is a set containing all the positive integers, zero, and the negative integers.
d. A solution set is a set containing rational numbers.

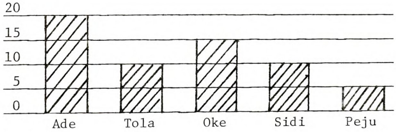
46. If we use the set concept to define the operations for the counting numbers, addition would be defined in terms of

    a. the intersection of disjoint sets
    b. the union of intersecting sets
    c. the intersection of sets with common elements
    d. the union of disjoint sets

47. If two sets are said to be equivalent, then

    a. every element in the first set can be paired with one and only one element in the second set
    b. every element in one set must also be an element in the second set
    c. they are intersecting sets
    d. one must be the null set

48. Look at the picture below:



Who got the most words right?

    a. Oke
    b. Ade
    c. Sidi
    d. Peju

49. How many words did Tola get right?

    a. 10
    b. 20
    c. 15
    d. 5

50. The picture shown in number 48 is called:

    a. a word picture
    b. a spelling test
    c. a bar graph
    d. an arithmetic picture

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