UNIVERSITY OF ALBERTA

RETHINKING THE SECONDARY SCHOOL MATHEMATICS PROGRAM IN TANZANIA

BY

JOYCE R. MGOMBELO ©

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled RETHINKING THE SECONDARY SCHOOL MATHEMATICS PROGRAM IN TANZANIA submitted by JOYCE R. MGOMBELO in partial fulfilment of the requirements for the degree of MASTER OF EDUCATION.

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DEDICATION

To the memory of my beloved father, Robert Mgombelo, and my beloved daughter, Chiku.

ABSTRACT

The primary concern of this study was to analyze the developments of the Tanzanian secondary school mathematics program since independence. The data collection and analysis of the study was guided by the following questions:

1. What changes have taken place in the patterns and philosophies of secondary mathematics education in Tanzania?

2. What reasons led to changes above?

3. What were the actual changes that took place in the secondary mathematics program?

4. What is the current status of the secondary mathematics program in Tanzania?

5. What were/are some of the major constraints experienced in achieving the goals of teaching secondary mathematics education in Tanzania?

6. What are the new directions and possibilities for the secondary mathematics program in Tanzania?

The study then attempted to examine the historical development of the secondary mathematics program and the present-day teachers' views about the mathematics program. This examination was done through document analysis and questionnaire sent to mathematics teachers.

As the analysis of the secondary school mathematics program developed, it revealed a number of findings which are summarized below:

1. There has been a mismatch between the aims of education

and the actions taken by teachers, for example, the aims of education as stipulated by Education for Self Reliance and the aims of mathematics education indicated in the syllabuses, and the aims implicit in the syllabuses and the actions taken by teachers.

2. A number of reasons for the above mismatch are discussed including the predominance of the discipline oriented view of mathematics curriculum and the imposition of the National Secondary Mathematics program to the teachers.

Finally, the study identifies some recommendations for future program development.

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CHAPTER 1

BACKGROUND AND OVERVIEW OF THE STUDY

Introduction

The period starting in the middle of the 20th century was that of unprecedented change in mathematics curricula of most countries of the world. The period following World War II was one of intense mathematical activity. New results were being developed. The general directions of these innovations were towards greater abstractions of thought. The influential role of technology in the war led to great emphasis in the post war period, on technology as a force for progress and development. This in turn, created a need for more technologists of various kinds. Mathematics, which has played such an important part in these technological achievements was given special emphasis in the drive for more and trained technologists.

There was a desire among many mathematicians to infuse the secondary school curriculum with the excitement of the new developments in mathematics and to bring school courses more into line with the university-level mathematics curriculum where the changes were first seen. As a result of these changes in the mathematics curriculum, a number of different theoretical approaches to curriculum development emerged, some simultaneously, some in reaction to earlier ones. Among the new mathematics projects started were the SMSG (School Mathematics Study Group) in the USA and the SMP (School Mathematics Project) in England.

While scientific and technological changes were igniting curriculum activity in the industrialized countries in this period, political ones were influencing the course of history in developing countries such as Africa. Many such countries were gaining their independence. At the time of independence, the newly independent countries sought assistance from the more industrially developed ones. Leaders of these countries demanded quick solutions to their problems and one of these was to develop scientifically-oriented manpower, so that great strides would be made towards economic liberation just as there had been during the political liberation. As with developed countries the New Mathematics curriculum was introduced in these countries. Numerous programs in mathematics made their way to curriculum centres in Africa. Examples of these were the School Mathematics of East Africa (SMEA) adapted from the School Mathematics Project (SMP) and the Entebbe Mathematics adapted from School Mathematics Study Group (SMSG) from the USA.

While New Mathematics curriculum projects were introduced in African countries, plans for educational expansion were made. As education expanded, curriculum issues were neglected as Beshir, (1974) explains,

> As education expanded, the problems of content and relevance of the curricula have been given less attention not because they were not important, but because there were more urgent problems.

The impetus for curriculum consideration came from the famous Addis-Ababa conference of 1961 which observed that,

> The content of education in Africa is not in line with either existing African conditions or the postulates of political independence ... but it is based on a non African background. (UNESCO, 1961).

The conference recommended that African educational authorities should revise and reform the content of education in the areas of curricula, textbooks and teaching methods so as to take into account the African environment, child development, cultural heritage and the demands of technological progress and economic development (UNESCO, 1961).

The guidelines above made little impact on the curriculum as Lewin (1985), observes,

> Relatively little curriculum development was in evidence during this time, most expansion merely building on existing syllabuses or weakly modifying them to remove some of the more obvious distortions inherited from the past.

This observation is still true for nearly all educational systems in Africa today. Although attempts have been made from time to time to change the school curricula with a view to making it relevant, both in content and methods, the changes have tended to be more cosmetic and lacking in imagination (Eshiwani, 1980).

This study is an analysis of the developments of the Tanzanian Secondary School Mathematics Program since independence; how the program came to be what it is; the various factors which came into play to produce the goals, and the subject matter emphasis.

Rationale for the study

Up until independence, British syllabuses were used in Tanzania. When Britain adopted the Jeffrey Report and the British Examination Syndicates produced examination syllabuses following the report recommendations, colonial Tanganyika followed suit.

At independence, new changes came through contact with foreign Mathematics programs which resulted from the New Mathematics wave in Western and North American countries. Two projects formed the basis for the New or Modern Mathematics in Tanzania. The Entebbe project which was written under the auspices of an American Company, Educational Services Incorporated and the School Mathematics Project which began in England were introduced into African English-speaking countries. The latter was modified to the School Mathematics Project for East Africa (SMPEA) and later to the School Mathematics for East Africa (SMEA). The two projects continued in Tanzania until the New National

Mathematics Curriculum was developed as a response to the demands made through Education for Self Reliance (ESR), a document which spelled out the framework for education in Tanzania (Nyerere, 1968).

ESR placed education in the forefront of the socialist construction. It directed that the education system should be reformed so as to:

1. reduce elitism and the tendency for schooling to further social and other inequalities and class formation;
2. develop a socialist and self-reliant value system among pupils and citizens;
3. integrate the school into the village community and prepare the majority for a life in agriculture rather than wage/white collar employment; and,
4. give priority to national development needs over social demand in determining the expansion of various educational sectors.

A general overview of the National Secondary Mathematics of 1976 shows the dominance of features of the New Mathematics projects such as the Entebbe Mathematics and SMP. The syllabus was designed by combining the 'best' features from the Entebbe Mathematics project and SMP. Thus despite the few changes which were made to the content of mathematics, the philosophies of the original New Mathematics projects were maintained (Mmari, 1980). The fact that these projects originated from the Western countries implies that none of the foregoing ESR directives had impact on the renewal of the mathematics curriculum at that time.

Modern Mathematics continued to be taught in Tanzanian secondary schools until 1988 when the new mathematics program for secondary school was developed. During this time a number of criticisms from different points of view were raised because of the failure in which Modern Mathematics resulted for many students. From the public point of view, many students were seen as lacking ability in computational skills. This led to a cry to return to the traditional mathematics. The idea that mathematics is a logico-formal system and should be taught accordingly met with fierce resistance from teachers; probably originally because of the demand for mastery of the content it required but increasingly because of the failures it produced for many students. Concerns about lack of motivation and interest on the part of the students in mathematics were expressed by teachers in different contexts.

The New Secondary Mathematics curriculum of 1988 was designed by taking into consideration most of the concerns raised against the syllabus of 1976. An overview of the syllabus shows the following two changes made in comparison to the curriculum of 1976. First, the topics are rearranged in terms of forms. Second, the specific objectives for each form and for each subtopic are identified.

The above discussion would suggest that the present secondary mathematics curriculum was designed without critically analyzing the epistemological and pedagogical issues related to the former mathematics programs on one hand and the Education for Self Reliance on the other hand. Lack of this critical analysis in the renewal process is detrimental to the Tanzanian secondary program for it can generate a program which sometimes incompatible with the national needs and the needs of all those concerned.

The purpose of the study

The main purpose of the study is to analyze the developments of the Tanzanian secondary mathematics program with a view to making recommendations for future mathematics curriculum development.

Guiding questions

In regard to the purpose of the study, the study attempts to answer the following research questions:

1. What changes have taken place in the patterns and philosophies of secondary mathematics education in Tanzania?
2. What reasons led to the changes above?
3. What were the actual changes that took place in the secondary mathematics program?
4. What is the current status of the secondary mathematics program in Tanzania?
5. What were/are some of the major constraints experienced in achieving the goals of teaching secondary mathematics education in Tanzania?
6. What are new directions and possibilities for the secondary mathematics program in Tanzania?

Significance of the study

The study seeks to reveal some of the problems associated with the development of the secondary mathematics program in order to propose new directions and possibilities for future secondary mathematics curriculum development. The findings will be helpful for various groups involved in the curriculum including teachers, administrators, mathematics educators, curriculum developers and decision makers.

1. The findings may provide teachers with better understanding of the secondary mathematics program.
2. The findings may provide decision makers and curriculum developers with data for future decisions concerning the revisions/changes of secondary mathematics program.
3. The findings may provide mathematics educators with a better framework for more meaningful and effective evaluation procedures.
4. Finally, findings from the study may provide some direction for future research.

Assumptions, delimitations and limitations

Assumptions

1. The first assumption is that no critical analysis of the secondary mathematics programs has been made in the renewal processes of the program in Tanzania since independence.
2. The second assumption is that questions asked on the teachers' questionnaire were meaningful and that they were interpreted accurately by those who responded to them.

Delimitations

1. This study concentrates on the analysis of the developments of the Tanzanian Secondary Mathematics program in its independence period, covering the period between 1961 to present.
2. Within the secondary mathematics program, the study focuses on the O'level secondary mathematics program.

Limitations

1. The study was undertaken outside of the environment of teachers, students and others involved in mathematics education in Tanzania. As a result, direct communication with people involved in the development of the secondary mathematics program was not possible.
2. The findings from the teachers' questionnaire may be somewhat situational, generalizations in the traditional sense will have to be made with caution.

Definition of terms

Curriculum: The term curriculum refers to a particular course of study, often in a special field, or all courses of study offered by an educational institution. In this study, the term will be used to refer to the mathematics course of study.

<u>Program</u>: In this study this term will be used to refer to all curriculum/experiences and their arrangement as planned for the secondary school mathematics.

<u>Syllabus</u>: A list of content area including objectives and learning activities.

<u>O'level</u>: This is the junior secondary school in the Tanzanian secondary school system. It comprises Form I to Form IV, ie Grades 9 to 12.

<u>A'level</u>: This is the senior secondary school in the Tanzanian secondary education system. It comprises Form V and VI, ie grades 13 and 14.

Organization of the thesis

This chapter has presented the general background and an overview of the study. In chapter two a review of relevant literature for the study is presented. The research design and methodology employed in collecting and analyzing data are described in chapter three. The fourth chapter establishes the historical background of the study from two perspectives. First it describes the evolution of the Tanzanian education system so as to establish a context within which the development occurred. In the second part of the chapter, an analysis of the curriculum materials of the secondary mathematics programs which had impact on the development of the secondary mathematics program in Tanzania is presented. The findings from a teacher questionnaire together with the discussion about the findings are presented in chapter five. In chapter six an examination of the changes in patterns and philosophies of the secondary mathematics program is presented. Also the chapter points out the factors which led to the changes. In chapter seven conclusions are drawn about the dynamics of the development of the program and the consequences to the present secondary mathematics program. Recommendations are made for future program development.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

In this chapter, a brief review of the literature related to the present study is presented. The chapter is divided in four sections. The first section presents a survey of the dynamics of mathematics curriculum development in African countries since independence of many of the countries. The purpose of this survey is to study the background related to the major research questions, and also to explain the setting in which most of curriculum innovations occured. In the second section a critical review of the methods used in curriculum evaluation is presented. The purpose of the review is to gain an insight into the methods used in evaluating programs. Such an insight will lead to the improvement of the research design. The third section presents a survey of the literature on new directions in school mathematics. The reason for this survey is to gain a necessary background for understanding the possibilities for the school mathematics curriculum and critically relate this to the research questions. The fourth section is a summary of the review.

Research in African countries

The three decades since independence was gained by most African countries could be characterised by three major periods of curriculum renewal.

Early independence and the struggle to determine curriculum

This period was characterised by efforts in defining appropriate content on the one hand. On the other hand an opportunity was provided for a severe and sustained critique of the colonial curriculum (Jansen 1989). Despite the above efforts, the issue which was given priority was education expansion. Uchendu (1979) observes that,

> Planning for educational expansion has ranked higher than curricula reforms in Africa's political agenda.

The reason for this emphasis on expansion among early independence is the fact that the colonial education system had restricted education to a very limited number of elite among the colonized, and had organized the entire social structure to make educational qualifications appear to be the route to social and economic mobility. In the content vacuum left by the withdrawal of colonial education, African countries became attracted to mathematics programs developed in the USA and Europe.

Experimentation with exogenous models of mathematics Curriculum

The new wave of the New Mathematics Curriculum which was generated within the industrialized countries made its way to Africa. Among the factors which made it possible for New Mathematics models to be accepted in Africa were:

1. Faith in science and technology as the primary basis for economic progress in industrialized countries. Such explanations gained popularity through the emergence of human capital theory (Schultz 1961) and hypotheses such as the stages of economic growth (Rostow 1960) which were wildly acclaimed in the West and promoted in Africa (Leys 1986 p. 170).
2. Intense interest in subject-based curriculum change, particularly in mathematics and science, which was generated in the post-Sputnik era in the USA (Jansen, 1989).
3. The absence of indigenous frameworks with which to formulate appropriate content in mathematics. As Lillis (1985) observes:

> The African independence movement ... lacked a clear curriculum policy dimension.

A number of programs in mathematics began to evolve in Africa. The most conspicuous initiating event in East Africa was a meeting at Entebbe (Uganda), in June 1962, of several mathematicians and mathematics educators from English - speaking Africa (Mmari 1980). Also, through the Centre of Curriculum Renewal and Educational Development Overseas (CREDO), the British School Mathematics Project (SMP) was accepted in Africa.

Although attempts were made to adapt the technological, Western-oriented mathematics curricula to African content, very little was achieved. As Kenner (1966) explains:

> The modifications envisaged to the SMP materials were in the first instance essentially non mathematical;
>
> (i) Significant language changes were necessary including alterations of many of examples to obviate, for example, the necessity of explaining what 'cricket' was before a particular example could become meaningful.
>
> (ii) It was necessary to adapt Books 1-5 (designed for a five year course in Britain) to fit the East African system of four years secondary schooling.
>
> (iii) Such modifications were made in the light of the assumption that Kenyan children were slightly more advanced at the 11 plus stage than UK children.

Recent emergence of critical models of mathematics Curriculum

There is a widespread perception that Western models of curriculum development are irrelevant to an African setting. This is revealed, for example, by the tremendous difficulty of successfully implementing such projects at the local level. As Lillis (1985) concluded from Kenyan Experience:

> The decision to abolish modern mathematics in January 1981 (thus) reflected a public crisis of confidence in modern mathematics education.

There was also a radical aspect to recently independent status with regard to the West and the adoption of some socialist variant of education which has led to very divergent curriculum trends from those observed in the 1960's and 1970's. The most popular socialist curriculum model to appear in recent times is generally referred to as Mathematics Education for Emancipation (Gerdes 1985).

Explaining the failure in post-colonial mathematics curriculum

A recent conference in Zimbabwe found that, while many reforms have been initiated all over Africa,

> much still remains to be done if African education systems, either in their curricula or their methods, are to be divorced from colonial systems (Yacine, 1986).

Also Hawes (1985) notes that:

> There is heightened concern that the nature, speed and extent of changes mounted in the 1960's and 1970's may have caused unacceptable gaps between official curricula and actual practice.

The following are some of the elements of curriculum failure noted:

1. Teachers: Inadequate levels of teacher training, their isolation from the design and planning of curriculum change; teacher resistance to change because of established practices and rewards. (Husen, 1978, D'Ambrosio, 1985).

2. Curriculum: The ambitious expectations of curriculum innovations are not matched with the realities of classroom practice; centrally developed curriculum materials are not

flexible with regard to local differences and diversity (Hawes, 1985).

3. Political: Curriculum concern, misguided by political and ideological emphasis, and not directed to reality (Heynman, 1971, Adegote 1987, Prewitt, 1971).

4. Evaluation: A lack of systematic evaluation as an integral part of the innovative project, and as a resource for further curriculum improvement. (Hawes, 1985, Meurvanyika 1986).

Curriculum evaluation methodologies

Evaluation can be defined as the process of attributing value to intentions, actions, decisions, performances, people, objects, etc. (Davis 1981). In its broadest sense, therefore, education evaluation is concerned with the value of education practices (Ernest 1991). Most evaluation studies use evaluation models. Evaluation models are frameworks or guidelines within which evaluation activities are conducted. Evaluators have used various models depending on how they perceive the process, that is, the assumptions and conceptions of education programs and evaluation in general.

Amongst the common models of curriculum evaluation are those which originate from education measurement, from the growth of scientific research in education, and from pressure of education accountability (Madaus, Striven and Stufflebeam, 1983). Howson et al refer to these models as 'engineering' models. In the engineering metaphor, the school is a factory and education is a production process. Pupils enter as raw materials and emerge at the end as finished products. The curriculum is seen as an instrument for converting raw material into the finished product.

Curriculum evaluation therefore requires a list of specifications, just as one would evaluate an automobile.

Hamilton and Parlett refer to these models as agricultural-botany evaluation models. They see agricultural-botany evaluation presented as an assessment of the effectiveness of an innovation by examining whether or not it has reached required standards on pre-specified criteria. Students, rather like plants, are given pre-tests (the seedling are weighed or measured) and submitted to different experiences (treatment conditions). After a period of time their attainment (growth or yield) is measured to indicate the relative efficiency of the methods (fertilizers) used.

Examples of evaluation models which fall under the above metaphor are the goal attainment models of Ralph Tyler, Hammond and Provus. Tyler's model, also known as the pretest/posttest model, originates from the conceptualization of the curriculum as a set of planned school experiences designed to help students achieve behavioral outcomes (Parlett, 1972, Stake, 1975). Tyler's approach to evaluation therefore involves establishing goals or objectives, stating the objectives in behavioral terms, measuring aspects of student performance at the completion of teaching, and lastly comparing the test results with behavioral objectives. For Tyler, therefore, emphasis is on the degree to which the content and method of a curriculum achieve the stated objectives.

Although a goal-attainment model, Hammond's model is more concerned than Tyler's with determining the influence of the institutional and instructional factors on the attainment of objectives (Brady 1987). Hammond (1973), quoted in Brady (1973), suggests five steps for determining whether a curriculum has achieved its objectives: isolating the program or part of the curriculum to be evaluated, defining the descriptive variables (all variables relating to school and instruction), stating objectives in behavioral terms, assessing the behaviour described in the objectives, and analyzing results to arrive at conclusions about the objectives.

The Provus goal attainment model, also known as the discrepancy model, involves deciding upon curriculum standards, determining whether a discrepancy exists between observations of the curriculum and the standards or objectives decided upon, and using the discrepancy information to identify weaknesses in order to improve the curriculum (Provus, 1973 quoted in Brady 1987).

The above models have been criticized by other evaluators in that they are designed to yield data of one particular type, namely, objective numerical data that permit statistical analysis (Parlett and Hamilton 1976). This reliance on one particular data type has shortcomings, as Stenhouse (1975), quoted in Ernest (1991) indicates:

> The translation of the deep structures of knowledge into behavioral objectives is one of the principal causes of the distortion of knowledge in schools noted by Young (1971), Bernstein (1971) and Esland (1971). The filtering of knowledge in through an analysis of objectives gives the school an authority and power over its students by setting arbitrary limits to speculation and by defining arbitrary solutions to unsolved problems of knowledge. This translates the teacher from the role of the student of a complex field of knowledge to the role of the master of the school's agreed version of that field.

The above models have one main advantage in that they are efficient in producing information on students' performance in many areas of the curriculum in a short period of time.

Other types of curriculum evaluation models are those which are rooted in social anthropology. Common to these models is the emphasis on the social anthropological approach which takes account of the wider contexts in which education innovations function (Parlett and Hamilton 1976).

The primary concern is description and interpretation rather than measurement and prediction. The metaphor applied to this approach to curriculum evaluation by Howson et al is that of journalism. The evaluator becomes a reporter, tracking down leads and using interviews and observations to put together a terse and timely report (Howson, Keitel and Kilpatrick 1981).

Examples of models which fall under this paradigm are the countenance, responsive and case study models of Stake (Stake 1967, 1976 and 1978, quoted in Brady 1987). The countenance model distinguishes between the evaluator's description and judgement at different stages of implementing a curriculum or program, antecedents, transactions and outcomes. Antecedents are any conditions existing prior to teaching and learning. Transactions are the succession of engagements that take place during instruction. Outcomes are the abilities, attitudes and achievements of students that result from the curriculum. The responsive model is especially sensitive to identifying problem areas. It is flexible and it uses the naturalistic setting in which to conduct evaluation (Brady 1987). Stake's case study model is so-called because it emphasizes the specific situation to be investigated. In summing up Stake's ideas in curriculum evaluation, Davis (1980) lists the following points:

1. The notion that evaluation could provide valuable information by describing and portraying a wide variety of elements associated with a program or events being examined.
2. The inclusion of values, judgements and views of people involved in the program.
3. The incorporation of both formal and informal techniques.
4. The importance of evaluation strategies being suited or responsive to both the particular problem and to the

needs of those wanting the information.

5. The idea of examining logical consistencies among aims, intended processes and hoped-for outcomes.
6. The idea of examining congruencies among intentions, actual processes and actual outcomes.

Another model which falls under the social anthropology paradigm is the Parlett and Hamilton's (1972) illuminative model of curriculum evaluation. This model resembles Stake's portrayal approach in that it takes into account the contexts in which the curriculum functions. Parlett and Hamilton claim that illuminative evaluation is concerned more with description and interpretation than measurement and prediction and that it aims to: examine the situational influences on a curriculum, the opinions of those involved as to the advantages and disadvantages, and how student performances are most affected; discern and discuss significant features of a curriculum, and the critical processes involved in implementing it; and identify all the desirable parts of a curriculum (Brady 1987).

The above model have been criticized by some authors. For example, Hughes et al (1978, quoted in Davis, 1981) see several problems in Parlett and Hamilton's model. First, it tends to set up an unnecessary separation between kinds of approaches, when aspects of each might be useful in particular situations. Second, it may make inappropriately strong claims for methodologies borrowed from other fields with established rules of procedure, but with little demonstrated value in curriculum evaluation. Third, the method and language in this field may become as esoteric and remote from teachers and other interested parties as conventional education research has become.

Other criticisms of the social anthropology approach to curriculum evaluation are given by Brady (1987). These are:

1. It is impressionistic and subjective rather than objective.

2. It is difficult to generalize the results to apply to other situations.
3. It rarely allows for findings or judgements to expressed in a quantifiable way.
4. It stresses the atypical or unusual in a situation.
5. It is not entirely clear just what is being evaluated.

More recently, there has been increased discussion on alternative curriculum evaluation methodologies. For example, drawing on the work of Jurgen Habermas (1972), Aoki (1978) outlined three orientations to curriculum evaluation, namely, the empirical-analytic orientation which reflect an achievement, goal-based mode of evaluation; the situational interpretive orientation which attempts to uncover the meanings and relevance which a curriculum has for those involved; and the critical theoretic orientation which attempts to make explicit the foundations underlying a program.

Alternative evaluation methodologies have been much discussed in recent years, but few have been applied to mathematics development projects, although some evaluation studies in the last few years have used techniques borrowed from these methodologies (Howson et al 1981). Howson et al see evaluators in mathematics curricula as being too eclectic in their approaches to permit a neat classification. They therefore classify the evaluation studies according to curriculum development approaches identified by them, namely, the New Mathematics approach, the behaviourist approach, the formative approach, the structuralist approach and the integrated approach. A close examination of the evaluation studies, especially those based on new mathematics and the behaviourist approach, shows the dominance of goal-directed or achievement evaluation. An example of these is the National Longitudinal Study of Mathematical Abilities (NLSMA) whose aim was to provide a more comprehensive and extended evaluation of pupils' performance in the New Mathematics curriculum programs in the USA (Howson, Keitel and Kilpatrick, 1981).

New directions in mathematics education

More recently there has been an increased emphasis in the literature pertaining to school mathematics curriculum on problem solving, practical and investigational work and discussion of the learner's attitudes to mathematics. Included in the literature available are the Cockroft Report in '<u>Mathematics Counts</u>' (Cockroft, 1982) and the <u>Curriculum and Evaluation Standards for School Mathematics</u> published by the National Council of Teachers of Mathematics (NCTM, 1989).

The Cockroft Report has three main features. First it specifies the aims of mathematics education and the mathematical needs of adult life, employment and further and higher education. Another feature is an emphasis on the computer and calculator as aids to enhance mathematics teaching and learning. The report also recommends that problem solving, discussion, investigational and practical work, as well as exposition and practice, be included in the teaching and learning of mathematics at all levels.

Among other features the NCTM curriculum Standards articulate five general goals for all students. These are: learn to value mathematics, become confident in the ability to do mathematics, become mathematical problem solvers, learn to communicate mathematically and learn to reason mathematically. Learning to value mathematics requires students to have numerous and varied experiences related to cultural, historical and scientific evolution of mathematics. Becoming confident in the ability to do mathematics requires students to view themselves as capable of using mathematical power to make sense of their own world. Becoming mathematical problem solvers requires students to be able to work on problems that require hours, days and even weeks to solve. In addition, students may work in small groups or entire classes to solve problems cooperatively and to solve some open ended problems having no right answer and even to pose some problems. Learning to communicate mathematically requires students to develop the power to use mathematics, which involves learning the signs, symbols, and terms of mathematics. Learning to reason mathematically requires students to be able to make conjectures, gather evidence and build arguments to support mathematics notions.

The Standards also discuss three principles with regard to mathematics content. First, that knowing mathematics is doing mathematics, in that an individual gathers, discovers or creates knowledge in the course of a purposeful activity. Instruction, therefore, should emphasize doing rather than knowing that. Second, with the computer's ability to process large sets of information, the curriculum for all students should provide opportunities to develop an understanding of mathematical models, structures, and simulations applicable to many disciplines. Third, the changes in technology and the broadening of areas in which mathematics is applied have resulted in growth and changes in the discipline of mathematics itself. The Standards therefore recommend the use of calculators and computers in schools and more specifically recommend the following:

1. appropriate calculators should be available to all students at all times.
2. a computer should be available in every classroom for demonstration purposes.
3. every student should have access to a computer for individual and group work.
4. students should learn to use the computer as a tool for processing information and performing calculations to investigate and solve problems.

With regard to instructional strategies, the Standards recommend the use of problem situations to teach mathematics concepts and procedures. Thus instruction should vary to include opportunities for:

1. appropriate project work.
2. group and individual assignment.
3. discussion between teachers and students and among students.
4. practice on mathematical methods.
5. exposition by the teacher.

Summary

From this review of literature, it appears therefore that there is an explicit need for the creation, articulation, and testing of alternative mathematics curriculum models which will match the vision of African countries (developing countries). The exchange of ideas among countries will always be a reality and should not be condemned or lauded uncritically as it has been with New Mathematics curricula experience.

Furthermore, it is clear from the critical review of the evaluation models and approaches that the empirical-analytical model, although useful in providing valuable information about a program, is limited in revealing other important aspects of a program which impinge upon real life or social situations of such programs. Alternatively there are other methods like situational-interpretive and critical-theoretic.

CHAPTER 3

PROGRAM EVALUATION

The nature of the study

This study is based on a premise that evaluation is a 'sense making' or interpretive activity (Werner, 1978) and the concept that different kinds of sense can be made of a program depending on the perspective of the evaluator. For example, while criticizing the contemporary evaluation procedures which he calls 'end-means' as being limited to only one perspective, Werner suggests adding two other perspectives to the ends-means perspective: one which he calls 'situational interpretive' attempts to uncover meanings and relevance which a program has for those involved; the other perspective which he calls 'critical interpretive' attempts to make explicit the foundations underlying a program. Werner sees the three perspectives as three ways of making sense of programs which differ from one another in terms of their purposes, appropriate datum, and methodological approaches. And since each of these perspectives allows an evaluator to generate data and make sense of programs in slightly different ways, they are not to be viewed as being in competition. In retrospect, Werner suggests a more encompassing model for program evaluation, one which incorporates all three perspectives. As he observes:

> An evaluator who has multiple perspectives at his disposal can gain a larger picture of any school program (Werner, 1978).

Since an important aspect of this study is an attempt to gain a larger picture of the secondary mathematics program in Tanzania by analyzing its developments since independence, data and methodologies which call for the multiple perspectives were used. Therefore, this study is both descripcive, historical, analytical, and critical in nature. The benefits of doing historical studies in curriculum evaluation are many and varied. Among them is the following as Goodson (1985) observes:

> Further, historical scrutiny offers insights into the existence of patterns and recurring constraints: why, for instance, certain 'traditions' in the school curriculum survive and others disappear.

The study then is an attempt to: examine the historical development of the secondary mathematics program (chapter 4); present present-day teachers' views (chapter 5); articulate the current secondary mathematics program (chapter 6); and critically reflect on new directions (chapter 7).

Procedure for data collection

In doing this study three methods were used to collect data and information. These were: (a) Document analysis; (b) a recollection of the reseacher's first hand personal experiences as a student and as a teacher in Tanzania; and (c) a questionnaire administered to a sample of teachers.

Document Analysis

Data from the above methods include the following:

1. An analysis of syllabuses and textbooks of the different secondary mathematics programs. These included the School Mathematics Project, the Entebbe Mathematics, the National Secondary Mathematics curriculum of 1976 and the National Secondary Mathematics curriculum of 1988.
2. Analysis of Government documents. These included the Education for Self Reliance document, Recommendations of the 1982 Presidential Commission on Education as approved by the Party and Government and the Basic facts of Education in Tanzania.
3. Analysis of other documents like the NCTM Curriculum and

Evaluation Standards and the Cockroft Report (Mathematics Counts) to understand new developments in Mathematics education.

4. The traditional techniques of Library research undertaken in the library system at the University of Alberta were used in selecting the literature relevant to the study. Journals, abstracts and books were used as a major source of information. These were identified by using the on-line computer catalogue, the ERIC data base, UNESCO data base and IDRC data base.

My personal experiences

This method of data collection involved the recollection of my own experiences as a student in Tanzanian secondary school and University and as a teacher in Tanzanian secondary school. My personal experiences relevant to this study are divided in two periods. First I was a student in secondary schools and university between 1972 and 1984. As a student in secondary schools, I was taught the Modern or New Mathematics curriculum as identified in the syllabus of 1976. Secondly, as a teacher of secondary school between 1984 and 1990 I taught both the 1976 and 1988 syllabuses. Thus, the developments of the secondary mathematics program were part of my experiences.

Questionnaire to teachers of mathematics

The questionnaire was developed by the researcher for use in this study. Items were constructed to incorporate some aspects of the secondary mathematics curriculum and aspects from surveys relating to the secondary mathematics programs and mathematics education in general.

The questionnaire consists of four parts. Part one of the questionnaire consists of items which sought information about the teachers' background and their demographic characteristics. Most of the questions are multiple choice.

Part two of the questionnaire consists of items which sought information concerning the perceptions of teachers on different aspects of the secondary mathematics program. These include teaching resources, teaching methods, factors influencing teachers in planning their lessons, assessment of time and student performance. Most of the items are of controlled choice. Part three sought teachers' views on the obstacles they encounter in teaching secondary school mathematics. Part four sought their reactions to a variety of recommendations for the new possibilities for the secondary mathematics program in Tanzania. A sample questionnaire is provided in Appendix C.

In general, the questionnaire was used to obtain a broad survey rather than detailed teachers' views. The questionnaire was validated by seeking expert opinion from mathematics education professors and graduate students in mathematics education at the University of Alberta. Because of the limitations of the study, the questionnaire was pilot tested using three secondary mathematics teachers in Alberta. Their responses and comments were addressed taking into account the different context in which the questionnaire was to be administered.

Participants

A major concern of this study was to identify participants who might provide valid data for the purposes of the research. Two criteria were used. The first criterion was to have teachers who would have participated in different activities in the area of secondary mathematics curriculum. The second criterion was to have teachers who would be willing to participate in the study. This was accomplished by cooperating with the heads of the schools in which the teachers were selected.

A total of 18 mathematics teachers from seven secondary schools participated in the study by responding to the questionnaire. All schools are located in Dar-es-Salaam.

Administration of the questionnaire

The questionnaire was mailed to a science education lecturer at the University of Dar-es-Salaam to be administered by him to teachers on behalf of the researcher. He was provided with the research proposal, together with a letter explaining the purpose of the study and the questionnaire and the various sections of the questionnaire.

Procedure for data analysis

The document analysis was loosely scheduled, because each of the sources of data described above generated new sources. Furthermore, as the study progressed new insights and ideas developed about the development process being studied and a framework of analysis, based on what was been learned, was constructed.

Data from the questionnaire were analyzed and presented in three stages. In the first stage, data were summarised to give brief explanations of the characteristics or opinions of the teachers. Numerical data from items with scaled responses were coded subsequently and frequencies and percentage distributions or mean scores of the responses were determined depending on whether the scale was continuous or not. The method of content analysis (Atkins, 1984) was used in analyzing the responses to open ended items. This involved a process of reading through all the responses to a particular question, and as the responses suggested some categories, these categories were recorded. In this way a complete set of categories for an item was built up and all responses were coded according to categories.

The second stage in analyzing questionnaire data involved a process of putting together and deriving key themes from the numerically expressed findings and from the categories identified.

The final stage of the analysis involved the process of combining key themes from different sections and, from this synthesis, trying to abstract meanings and focus such meanings on the research questions.

CHAPTER 4

HISTORICAL BACKGROUND OF THE PROGRAM

This chapter presents the historical background of the secondary mathematics program in Tanzania from two perspectives. In the first section the evolution of the Tanzanian education system is presented. The intent of presenting this is to gain insight into the context within which the development of the progam occurred. In the second section an analysis of the curriculum materials of the programs which had impact on the program is presented.

The structure of education system of Tanzania

Historical note

The United Republic of Tanzania, which encompasses the Mainland formerly known as Tanganyika and the islands of Zanzibar, Mafia and Pemba in the Indian Ocean, is located on the east coast of Africa. Its total area is 945,000 square kilometres, including the 59, 050 square kilometres of inland water. It has a population of 17,551,921 (1978 census). Over 90% of the population live in the rural areas. The economy is predominantly agricultural. The history of the Tanzanian education system is a reflection of the periods of political and socio-cultural upheavals through which the country has passed. In general, the history can be divided into three major periods, namely, precolonial, colonial and after independence.

The precolonial period

This period was marked by the education systems related to the various kinds of existing production system. Both formal and informal education were provided to the young. Informal education began at a very early age and was provided separately to the boys and girls. This was because of the division of labour. Girls, for example, were taught by their mothers, elder sisters and grandmothers how to prepare food and boys were taught animal husbandry by their fathers, elder brothers and their grandfathers.

Formal education in most Tanzanian societies existed in the form of 'schools' set up separately for boys and girls at the time of puberty. The purpose of these schools was to initiate youth into the adult ranks of society. Certain elders were assigned to teach the boys or the girls about tribal history, religion and all the skills and knowledge which an adult man or woman was expected to possess in order to function intelligently in his or her life. In most of these schools, circumcision was the final stage.

<u>The colonial period</u>

The period of colonization in Tanzania was marked by the establishment of various schools serving the interests of the various religious, political and business groups. These groups included the Arab slave traders, missionaries and rulers, the Christian missionaries, and the German and British colonizers.

The Arabs introduced schools which were known as 'madras'. Children were instructed on the Islamic Koran. The Arab slave traders introduced the Arabic culture and language both on the coast and in the hinterland through which their caravans passed. Many words in the Kiswahili language, for example mathematical terms of measures of length, capacity, time and calendar, are a result of this influence.

Christian missionaries penetrated the interior of the Tanzania Mainland (Tanganyika) prior to formal colonial rule, setting up churches, schools, workshops and trading centres. The missionaries as well as their metropolitan sponsors did not separate their religious role of converting the native to Christianity from their economic role of establishing commercial agricultural production and externally oriented trade. All this was perceived as their mission of civilizing Africa. Mission schools were mainly bush schools with classes from one to two years' duration. Children were taught literacy, numeracy and catechism in their vernacular languages. Staff of these schools were mainly African catechists who depended for their living on their own household's agricultural production plus a contribution from the local people. Schools were built by the local people on the land they provided. In addition to these schools, missions had central schools of up to standard four and later to six or more. A very small percentage of the youth entered central mission schools. The schools produced catechists, artisans, teachers and modern farmers. The curriculum was mostly vocational, masonry, carpentry, tailoring, road construction and agriculture, depending on the economic needs of the specific mission.

When the Germans colonized Tanzania, administrators (German) first depended on the mission and Islamic educational and religious institutions. Once the colonial state was established, the role of missions in reproducing the colonial economy and the colonial superstructure was strengthened. The German colonial administration also made use of Islamic educational and political institutions in order to create the 'akida' and 'liwali' system of direct rule.

The Germans also built a few Government schools. The schools were related to specific manpower needs, for skilled labourers, teachers, clerks etc. The primary aim was to prepare the cadre which would serve in the colonial service, in the plantations opened by the farmers, and in the business houses of the German merchant, who brought in manufactured goods and sent away raw materials produced by African labour on German-owned plantations. The structure of the German education system followed a pyramidal pattern like that of the missionaries. However, the German pyramid structure had a narrow base compared to that of the missionaries which had the bush schools as the foundation. Government school training was restricted to boys and the central schools were for the sons of the chiefs and/or wealthy Africans.

The education system during the period Tanzania was under the British rule was that of the separate racial school system. Three distinctly different school systems developed: African, Asian and European. They were separated from each other on a racial basis and divided internally into education for 'leaders' and education for the 'masses'. The Europeans and Asians had a much more developed education pyramid than the Africans. The European one was rooted in the metropolitan system and the children received their higher level of schooling in Europe. Primary and secondary education developed at a faster rate for Asians than for Africans. African education was limited to standard six and thereafter with limited expansion to standard eight. The schools were vocational and used vernacular or Swahili as the medium of instruction at the elementary level and Swahili for most central school advanced courses until 1945.

As a result of the emphasis on the low level education for the majority of African students, the British colonial administration was faced with increased demands for better qualified Africans to work in government departments and in private business. Thus, the central school curriculum was improved so that African students could enter Makerere (Uganda) secondary level courses. In 1934, for example, Tabora and St. Mary's at Tabora were upgraded to junior secondary schools. Later, other schools, for example, Kibosho, Tosamaganga and Minaki, followed. The secondary schools used English as the medium of instruction. The Cambridge Syndicate was relied upon by both Tanganyika

(Tanzania Mainland), Uganda and Kenya for setting and marking the examination at form four and later form six.

Later, in the Five-Year development plan (1956-1961), which led up to the period of independence, the British shifted emphasis from lower primary education to middle and post-primary education for Africans. Middle school places were to be increased by 50%, secondary education was expanded and higher school certificate courses introduced. Thus, by 1960 three secondary schools offered higher school certificates and there were students overseas, mainly in university programmes.

The period after independence

The period after independence marked a great activity in the education system in Tanzania. Immediately after independence Tanzania made some changes to the education system inherited from the British. One of the first reforms in education after independence was the integration of the school system in order to eliminate racial and religious discrimination. The education ordinance of 1961 established the policy of a racially integrated school system managed by government and voluntary agencies. Fees were controlled in order to foster the integration of high-cost schools. Also, selection to secondary school relied on Primary School Leaving Examinations. English and Swahili became the media of instruction in 1965. By 1968 Swahili became the medium for all primary schools except for the few primary schools which serve high income Tanzanian households.

Another reform which Tanzania made in the education system was the expansion of both primary and higher education. In both the Three-Year Development Plan, 1961-1964, and the Five-Year Plan, 1964-1969, expansion of secondary and higher education was given priority. In 1961 the University College of Dar-es-Salaam opened with a

Faculty of Law. University selection was based on performance on the form-six examination and form five selection depended on performance on the form four-examination. The examination relied on the Cambridge Syndicate until 1971 when National Examinations were established. In 1964 secondary school fees were abolished. The Five-Year Plan called for expansion of all four-year primary schools to reach standard seven. Standard eight was phased out. Primary school fees were abolished by 1973.

In 1967 TANU (Tanganyika African National Association), the ruling party of Tanzania Mainland, proclaimed the 'Arusha Declaration', a major ideological statement of the national policy of socialism and self reliance. Soon after this the Education for Self Reliance (ESR) document was issued. This document outlined all the aims and objectives of education in Tanzania in line with the 'ujamaa' (socialism) ideology. Some of the changes which were made to implement Education for Self Reliance were the nationalization of all assisted schools formally run by voluntary agencies, reinforcement of the powers of the Ministry of National Education over all aspects of the school system including control over curriculum and selection procedures, and rapid Tanzanianization of Heads of public and technical secondary schools and Colleges of National Education. In November 1974, the Party's (TANU) Executive Committee sitting in Musoma passed what is popularly known as the Musoma Resolution, a directive calling on the government to ensure that it produces truly self reliant people ready to play their part fully in the development of their society. The directive insisted that primary education should be terminal and the youths should be prepared for life in the community, which is predominantly rural. Secondary education, which should be terminal, should impart skills to the youths which would enable them to enter directly the various middle level sectors of the national economy. The resolution further directed that university education should be for workers and peasants.

The present Tanzanian education system

Despite of the changes which took place in the education system in Tanzania, the structure of the school system is basically that of the British. The structure is pyramidal and follows the 7 - 4 - 2 - 3+ pattern whereby there are seven years of Primary Education (Standards I - VII); four years of Lower Secondary Education or Ordinary Secondary Education (Forms I - IV); two years of Higher Secondary Education or Advanced Level Secondary Education (Forms V - VI) and three or more years of Tertiary Education at university and other higher institutions of learning. In general, Tanzania has so far been following an education system which falls into three main levels: Primary, Secondary and Tertiary.

As indicated above, the present education system has a pyramidal structure in that, the higher the education level, the fewer the number of places in the schools. Hence not all primary school leavers get places in secondary schools. Likewise, not all form four leavers get places in higher secondary schools and not all higher secondary school leavers join the university. Moreover, the number of students who get a place in secondary schools and higher educational institutions is very small in relation to the population of the country. Selection for those who enter the higher levels is based on examination.

The programs that had impact on Tanzanian secondary mathematics program

Analysis of SMP syllabus 1966

The SMP was initiated by the heads of mathematics of four public schools in England, together with Professor Bryan Thwaites of Theoretical Mechanics in the University of Southampton, in 1961. The intention was to reform the teaching of mathematics in the four schools to reflect modern developments in the subject and its wider usage, and to encourage other schools to do the same. The intention was a reaction to the concern expressed both in USA and in the UK about the pressing need for a new era of mathematical applications after Sputnik I was launched by the Russians in 1957.

The major aim of the SMP O'level syllabus was to make school mathematics more exciting and enjoyable, and to impart knowledge of the nature of mathematics and its uses in the modern world. In this way it was hoped to encourage more pupils to pursue further the study of mathematics, to bridge the gulf between university and school mathematics, both in content and outlook, and also to reflect the changes brought about in the world by increased automation and the introduction of computers (Thwaites, 1972).

As with most new mathematics syllabuses, one of the main changes to the traditional syllabus was an increased emphasis on algebraic structure. Sets, matrices and vectors were mentioned in the examination syllabus and concepts such as associativity, commutativity, relations and groups were introduced in the text. Algebra was to be treated in such a way that something of the nature of algebraic concepts was conveyed at the O'level rather than a definite body of knowledge imparted. Definitions and axioms were to be allowed to grow from concrete illustrations with which the pupil was familiar. For example, in teaching differential and integral calculus, the student at O'level was to learn how to draw graphs of functions and how to find rates of change and areas under graphs by drawing. At A'level, the more formal language of calculus was introduced, and finally at the university, a student was given a higher treatment that is a completely formal and rigorous account.

In order for the time to be available for the new topics introduced, complications of the examples to which the ideas are applied were de-emphasized rather than elimination of large parts of the traditional syllabus. Thus, although a student was expected to have a reasonable facility in solving simple and simultaneous linear equations, factorising, operating on simple algebraic fractions and using indices, the emphasis was on his understanding of the processes involved rather than on his ability to cope with complicated applications.

Other changes which the SMP syllabus proposed were in the treatment of geometry. It was argued that, for the majority of students, the traditional formal geometry offered little training in logical reasoning and emphasized, instead, practice in memorising of proofs of no particular worth. Therefore, the study of Euclidean space by means of geometric transformations of rotation, reflection, translation and enlargement was substituted in place of the traditional approach. Coordinates, vectors and displacements were to be introduced much earlier than it was with the traditional syllabus and the interplay between algebra and geometry was emphasized throughout the course. For example, geometrical transformations could be expressed in matrix form to yield simple examples of groups. Also, more attention was given to three-dimensional geometry. Topics like construction of polyhedra, plan and elevation were included in the syllabus to help a student to accustom himself to the nature of three dimensional space.

Other topics included in the syllabus were the study of trigonometry, inequalities, basic operations of arithmetic and elementary statistical ideas. The approach to trigonometry was based on the study of components. This served as the preparation for later work in vectors as well as introducing the trigonometrical functions as functions of angles and not as ratios connected with right angled triangles. With this the extension to angles of any magnitude was assumed to be natural and immediate. Inequalities were included because their study both algebraically and graphically could lead to interesting simple examples in linear programming as well as direct attention to reasons underlying some of the algebraic processes. In the same manner, it was proposed that the basic operations could be studied by the binary numbers and other number scales. By working on a simple scale like the binary, students were expected to concentrate on place value and understanding the operations.

Elementary statistical ideas were also introduced with special attention to the presentation, tabulation and grouping of data. Statistical measures were to be defined with the emphasis on the organization and interpretation of simple data and not on the technique of calculating. Some work was included on elementary probability and the students were expected to be able to calculate easy compound probabilities by deduction. In order to save time for numerical computations and also to help students to form the habit of estimating the size of the answer they expect to obtain, the use of slide rules was encouraged and three figure trigonometrical tables would be used.

Throughout the course, the syllabus proposed the shift of emphasis towards mathematical ideas and away from manipulative techniques. Manipulative techniques were to be postponed until the post-O'level. The list of contents of the syllabus are shown in Appendix A.

As it can be seen from the Director's report (Thwaites 1972), no attempt appears to have been made to set out the course objectives in detailed behavioral terms. The syllabus was more open and heuristic in its approach. It was assumed that, by this approach, the students would learn by discovery. Therefore, the syllabus advocated discovery teaching as a teaching strategy.

A further examination of the changes which SMP advocated to the secondary mathematics curriculum reveals the developers' belief about the nature of school mathematics knowledge. For example, in teaching algebra, the syllabus tried to convey something of the nature of various algebraic concepts rather than to impart a definite body of knowledge. Also the director's report of 1962/63 maintained that,

> We attempt to give a treatment of modern algebra similar to that which has been evolved over the last fifty years for teaching the differential and integral calculus. In this the pupil learns at a fairly early stage how to draw graphs of functions and how to find rates of change and areas under graphs by drawing. At the age of sixteen or so the more formal language of calculus is introduced and stage B of the pupil's calculus begins. Finally at the university the student is given a stage C treatment, that is a completely formal and rigorous account.

Clearly we can see from such accounts that school mathematics was understood to be like the discipline itself, a pure hierarchically structured self-subsistence body of objective knowledge (Ernest, 1991). Higher up the hierarchy, mathematics becomes increasingly pure, rigorous and abstract. Therefore, by learning mathematics from O'level to A'level and finally to university, a student is encouraged to climb up the hierarchy.

Furthermore, the relationship of mathematics to other disciplines or its applications is that applications are seen as mere techniques. The syllabus mentions that definitions and axioms must be allowed to grow out of concrete illustrations with which a pupil is familiar. But it also maintains that emphasis should be given to mathematical ideas and taken away from manipulative techniques. Thus it can be seen that the abstraction of mathematical concepts from the concrete illustrations is the only concern and not the complete cycle of modelling, that is, completing the same procedure of abstraction from the concrete illustrations in the reverse order.

Because of the nature of the SMP syllabus, that is open and heuristic in approach, the anticipated teacher's role is that of a lecturer and explainer communicating the structure of mathematics meaningfully. Various approaches and demonstrations and activities should be employed to motivate and facilitate understanding. Textbooks should be used. However computational tools like calculators should be used after mastery of concepts.

Analysis of the SMP student textbooks (Books 1-4)

The open and heuristic nature of the SMP approach is very much seen in the textbooks. The books introduce a variety of concepts and topics taken to varying depths, including the notion of set, mapping, group, vector, matrix and some topological ideas together with linear programming, transformation geometry, computers and programming, statistics and probability. Topics such as relation, function and number system are linked with the concept of set which is the basic idea in the course and serves as the main unifying idea. The emphasis is on conceptual learning. However, formalization is anticipated to occur later with increasing mathematical maturity.

The treatment of geometry is much as proposed by the syllabus. The SMP books introduce geometry by first laying greater emphasis on the appreciation of spatial relationships combined with deductive proofs within simple logical patterns but not examining the student on the whole structure. This is met in Book 1 on chapters on angle, polygons and polyhedra, area and symmetry. Angle is introduced as a turn measure and plenty of opportunities for discussion are provided before degree measure is defined.

The chapter on polygons and polyhedra is designed to give more examples on construction of models. This is expected to develop further appreciation of spatial relationships. Area is treated in such a way that the focus is on the region bounded by the curve and not the curve itself. Formula is introduced after many activities on area, for example, counting squares bounded by regions.

The study of Euclidean space by means of transformation geometry is observed in SMP books. The chapter on symmetry in Book 1 is supposed to lay the foundation for this. The symmetries met in this book are symmetry in planes and lines and rotational symmetry about axes and points. The transformations are treated in Book 2 in chapters on reflection and rotation, translations and vectors, and topology. Again the idea in this book is to develop geometrical intuition; the algebraic aspects of the transformations are postponed until later books (higher levels).

In order to illustrate how the topics are treated in SMP books, let us see how a lesson is developed in one of the chapters in one of the books. We discuss the chapter on coordinate geometry in Book 1. This topic is introduced in Book 1 and used as a mathematical tool throughout the O'level course. The topic in this chapter is introduced from different experiences. First the idea of an ordered pair is introduced from an idea of a sitting plan in a class. Here the student is expected to think of an ordered pair as representing a position of a student in a class in terms of the column and the row he sits in. For example, (5,3) means fifth column and third row. Then the student is introduced to the idea of street plan and maps. Here again the student is expected to develop the idea of an ordered pair as representing crossroads. The lesson is developed through the idea of labelling positions of cities, mountains and countries on a map by using an atlas. Two methods are discussed, the atlas method which locates a square and then the grid method which locates a point. The idea is for the student to see that a square is sufficient to pin-point a small object.

After the above examples, the idea of coordinates is introduced using grid method on a plane covered with a network of lines. Then, after naming the lines in one direction X lines and in the other direction Y lines, and using the idea that a line is a set of points, a point is defined as the intersection of two lines, one X line and one Y line. Then the coordinates are defined. Then the equations of X lines and Y lines are developed from this idea and the idea of coordinates representing distances from the origin in different directions discussed.

Finally, in this chapter the idea of coordinates in three dimensions is discussed. Again this is introduced by adding the coordinate representing height above sea level on a contour map and then an example of a cube given.

We can see from above that the textbook reflects the ideas proposed by the SMP syllabus. The textbook presents the topic to place emphasis on the development of a concept, in this case a coordinate. Although the topic is developed from different experiences, for example, a sitting plan in a classroom or maps, the emphasis is the abstraction of concepts of coordinates, an ordered pair or point. However, no application of these concepts to real life or other disciplines is presented.

The chapter to some extent reflects the image of the learner as an inquirer of mathematics concepts. By representing the topic from the student's familiar experiences, the learner is expected to discover the structure of mathematics from these experiences. However, with the absence of applications, the student is expected to discover the concept intuitively. Since abstraction of mathematics concepts is not easy for most of the students, it is likely that this method will favour a minority of students in the upper range.

By developing the topic using familiar experiences of the students, the textbook shows where and when mathematics is useful in real life. But without sufficient details in applications, the ability of applying mathematics ideas in real life is highly questionable. Thus the interaction of mathematics and society is not made clear.

The spiral approach and the idea that concepts are developed from concrete illustrations with formalization awaiting mathematical maturity demands more work of the teacher. For example, in the topic of coordinate geometry, after defining the point and coordinates, the chapter ends and the topic is covered in piecemeal in other chapters and other books. In this way the subject development tends to be disjointed. Also, the absence of sufficient applications require the teacher to set more exercises.

Analysis of the Entebbe Mathematics syllabus

The Entebbe Mathematics was a result of the African Mathematics Program initiated by the African Education Program. The African Education Program was initiated by a USA curriculum reform organization known as Educational Services Incorporated (ESI). The intent of initiating the African Education Program was to bring to bear within Africa the talent of African scholars and educators upon something that will approach a Pan-African level; to offer to them the direct and continued assistance of American and European educators with curriculum experience; and to mount within Africa massive curriculum reform programs of the sort that had been so influential in other parts of the world (SEPA, 1975).

As mentioned above, the motivating force of the Entebbe Mathematics Project was the United States of America. Consequently, the syllabus and the textbooks of the Entebbe

Project reflected those of American New Mathematics programs, especially those of the School Mathematics Study Group (SMSG). The major aim of the Entebbe Mathematics Project was to reform school mathematics in the light of new and modern discoveries.

One of the changes which Entebbe Mathematics proposed was the introduction of some of the modern concepts as early as possible. The topic of set was considered to be a unifying concept for many topics. Topics introduced included functions, transformation geometry, matrices, axiomatic algebra, statistics and probability.

Another feature of Entebbe mathematics was the stress on understanding. It was viewed that mathematics is more than doing and that the most important thing in mathematics was not mechanical doing but understanding with appreciation. As an attempt to facilitate understanding, Entebbe Mathematics placed emphasis on the structure of mathematics. At very early stages a pupil was to be led to discover the patterns in the structure of mathematics. Thus, for example, in teaching arithmetic emphasis was directed to the properties of operations like commutativity and associativity.

As a consequence of the above feature, Entebbe Mathematics put more stress on rigor. Mathematics was to be presented in the rigorous deductive spirit at early stages with the degree of rigor increasing as the pupil advanced to the higher levels of study. The spiral approach to curriculum was to be used in which the same subject arises at different times with an increasing degree of complexity and rigor. The use of the spiral method enabled the same concept or theorem be dealt with upon several occasions in the curriculum, separated by varying intervals of time. On each of the above occasions, several approaches were to be employed in order encourage students to use different methods of solving a problem.

Entebbe Mathematics emphasized the use of mathematics language and notation. It was hoped that, by making the language available to the students, it would help them in thinking and talking about mathematics. Also, this will ensure rapid communication between the teachers and students.

From the discussion we can see that the Entebbe mathematics developers' view of school mathematics was like that of the SMP developers. They also viewed mathematics as a discipline itself, a pure, hierarchically structured self-subsistent body of objective knowledge. Unlike SMP, which tries to develop mathematics concepts from concrete illustrations, the Entebbe puts much emphasis on rigor at very early stages. Therefore, for Entebbe mathematics the learner is assumed to internalized the pure conceptual structure of mathematics which is seen as a hierarchical network of concepts and propositions interconnected by logical links, mathematical relationships and fundamental ideas mirroring the organization of mathematics. It is assumed that properly learned mathematics knowledge will enable students to solve the problems.

The methods of teaching are inherent in the nature of the subject knowledge itself. In this, the role of the teacher is seen as that of an explainer communicating the structure of mathematics meaningfully. The teacher should enrich the course with additional problems and activities, adapting the structured textbook approach.

Analysis of the Entebbe Mathematics textbooks

The Entebbe mathematics textbooks reflect very much the proposals indicated in the syllabus. The books are tightly axiomatic, and try at every stage to set the work on a firm footing. The aim is to make the student answer the question why at every stage. The books for form 1 - 3 are divided into two volumes, one labelled algebra and the other geometry. The form four book comes in one volume and includes both algebra and geometry. Like the SMP books, the Entebbe books include chapters on transformation geometry, matrices of simple transformations of the plane, standard school arithmetic, algebra and trigonometry. The books include also statistics up to the concept of spread and probability for finite sample spaces, functions as distinct from relations, inequality and simple linear programming and three-dimensional problems including plans and elevations (in 2 and 3 dimensions).

The treatment of geometry is different from that of SMP books. While the Entebbe books use transformation geometry like SMP books, the Entebbe books first lay a foundation of congruent and similar triangles work. These are treated in Book 2 (geometry) to lay a foundation for transformation geometry in later books. The congruence and similarity of triangles are introduced by formal axiomatic geometry. The student is first introduced to proof and postulates and is expected to think abstractly right from the outset. Congruence of triangle is studied in detail and theorems are formally proved.

The treatment of algebra is such that emphasis is on the structure and formal axiomatic approach. Properties of roots (radicals), indices (exponents) and logarithms are proved as theorems. Also the standard of manipulative algebra is difficult compared to that of SMP books. For example, completion of the square of the quadratic function to find its maximum or minimum and the rationalization of the denominator of an irrational expression are included in the books.

To show how the lessons are developed in the books, the chapter on coordinate geometry in Book 4 is discussed. As we have seen above, algebra and geometry are treated in different volumes from form 1 - 3. It is in Book 4 where the interplay between algebra and geometry is treated in detail. The subtopics discussed in this chapter are introduction, horizontal and vertical lines, use of analytic methods in geometrical proofs, slope of the line and parallel and perpendicular lines. Others are equations of a line, distance formula, further use of analytic methods and coordinates in space.

The chapter introduces coordinate geometry or analytic geometry as a study of geometric figures and derivation of their properties by use of arithmetic and algebra. This is done by setting up a one to one correspondence between the points on the plane and ordered pairs of real numbers. Then a discussion of coordinates on a number line and on a plane follows. Both ideas of coordinates on the line and on a plane are discussed by formal language and definitions given formally. For example, to coordinatize a line the following description is given:

> Remember that when we coordinatize a line l in the plane, we choose an arbitrary point O on l, and assign to it the coordinate zero. We choose a second point A ≠ O on l and assign to it the coordinate 1. This is equivalent of saying that OA is our unit of length. Suppose now P is a point on l and that OP = a. We assign P the coordinate a if P is on the ray $\overrightarrow{OA}$ and -a otherwise.

After discussing a distance between two points on a line as PQ = |b - a| where a, b are coordinates of P and Q respectively, the idea is carried to the plane. The intent is to show a one-to-one correspondence between a point on the plane and an ordered pair of real numbers.

The same approach is used in the discussion of horizontal and vertical lines. For example, in the discussion of the equation of x-axis the following description is given:

> Suppose a point P(a,b) lies on the x-axis. The foot of the perpendicular from P onto the y-axis is the origin. Since the origin has coordinate zero on the y-axis it follows that b = 0.

> Conversely if b = 0, the definition of the ordinate shows that P lies on the x-axis. Hence the x-axis is the set of all points P(a,0). In the set notation we may describe this axis thus: $\{(x,y) \mid y = 0\}$. We then say simply that an equation of the x-axis is y = 0.

After a discussion of the use of analytic methods in geometric proofs, a discussion and proofs of formulas for distance between two points in the plane, slopes of lines, midpoint of line on a plane are presented. Also, the discussion of parallel and perpendicular lines follows the same approach, as does the discussion on coordinates in the space. In all these, emphasis is on formal proofs and precise mathematics language.

From the discussion above, we can see that the Entebbe books reflect the features of the syllabus. The books emphasize the development of concepts and understanding of the structure of mathematics. Unlike the SMP books which develop concepts from practical situations, the Entebbe books discuss them from the formal and axiomatic perspective, as demonstrated above. Again, throughout there is no reference to real life or other disciplines except for very few applications which appear in the exercises. As pointed out with respect to the syllabus, the student is expected to apply ideas developed in this way to real life or other disciplines.

The chapter described above reflects to some extent an image of the learner as actively involved in guided discovery of the structure of mathematics. However, as we have seen, this demands at an early stage a degree of conceptualization of which the average student is incapable. At the same time, since formalization reduces the emphasis on the applications of mathematics, the students' motivation to understand and master it is also reduced.

The relationship between the subject and society, therefore, is that society and mathematics are presented as two separate things. The emphasis on the axiomatic approach and rigor suggest that mathematics be studied for its own sake.

It can also be seen that the Entebbe books demand that teachers have a sound mathematical background. Because of the language and symbolization presented in the books and the verbose nature of the materials, teachers have to introduce the topic in their own words when necessary and they must show the possibility and manner of application of mathematics.

<u>Analysis of the National secondary mathematics syllabus 1976</u>

The National secondary mathematics syllabus of 1976 was developed as a response to the Education for Self Reliance (ESR), a document which spelled out the framework for education in Tanzania. ESR placed education in the forefront of the socialistic construction. The education system was to be reformed so as to:

1. reduce elitism and the tendency for schooling to further social and other inequalities and class formation.
2. develop a socialist and self reliant value system among pupils and citizens.
3. integrate the school into the village community and prepare the majority for a life in agriculture rather than wage/white collar employment; and
4. give priority to the national development needs over social demand in determining the expansion of various educational sectors.

The National secondary mathematics syllabus was designed by combining the 'best' features from the Entebbe program and the SMP, as Lillis (1985) observes:

> In Tanzania, for example, consistence with the philosophy of the Arusha Declaration, and the resulting desire to avoid obvious relationship with British (SMP) or American (Entebbe) mathematical philosophies, an attempt was made to

> create a specifically Tanzanian Mathematics program, utilizing elements of both in a program, intended to combine an almagam of the best of each.

The syllabus contains the general objectives of teaching mathematics in Tanzania secondary schools and a list of topics. The general objectives stated in the syllabus are:

1. to develop mathematical skills among pupils which will enable them to function in all practical affairs of life.
2. to provide pupils with a mathematical tool which they can apply in other subjects.
3. to develop pupils' abilities to discover mathematical concepts and ideas and also their ability to think logically.
4. to prepare pupils for higher studies.

The topics included in the syllabus are number, rate, ratio and proportion, approximation and accuracy, sequence and series, matrices, vectors, geometry and sets. Others are transformation, enlargement, circle and sphere, trigonometry, statistics and probability. Others are kinematics, plan and elevation and simple book-keeping.

As we have seen above, the National mathematics syllabus was an amalgam of the Entebbe and SMP syllabus. This fact is very much seen in the syllabus. For some topics like geometry and coordinate geometry, the emphasis seems to be on an axiomatics approach like that of Entebbe Mathematics. On the other hand, although the syllabus mentions applications, it puts more emphasis on understanding of mathematics concepts than on skills. This feature is like that of the SMP syllabus. Topics in which application of concepts is mentioned include rate, ratio and proportion, transformation, enlargement, circle and sphere, trigonometry, statistics, kinematics, plan and elevation and simple book-keeping.

The nature of school mathematics, as viewed by the curriculum developers of this syllabus, is like that of the SMP and Entebbe syllabuses. Mathematics is understood to be a pure, hierarchically structured, self-subsistent body of objective knowledge. Higher up the hierarchy, mathematics becomes increasingly pure, rigorous and abstract. While this view is shared by both the SMP and Entebbe, their approaches differ. For the SMP, concepts have to grow from concrete illustrations, with the degree of abstraction increasing with increasing school level. And for the Entebbe approach, rigor is emphasized at very low levels of schooling. Therefore, the idea of the this syllabus to be the amalgamation of the two syllabuses seems to be feasible for different topics and not the same topic. This idea will be explored further on the analysis of the books.

As with SMP and Entebbe, applications and the relationship of mathematics with other disciplines are mentioned but with emphasis shifted towards the abstraction of concepts. Also, like Entebbe, properly learned mathematics knowledge is assumed to enable students to solve problems.

Once again in this syllabus the teacher's role is seen as that of explainer, communicating the structure of mathematics meaningfully. The teacher should enrich the course with additional problems and activities adapting the structured textbook. The students are expected to discover mathematical ideas and concepts, as mentioned in one of the broad objectives.

<u>Analysis of textbooks for the National syllabus of 1976</u>

As discussed above, the syllabus of 1976 was an amalgamation of the Entebbe and SMP syllabuses. An examination of the textbooks for this syllabus shows the dominance of the Entebbe approach over the SMP. The books include chapters on transformation geometry, matrices of simple transformations of a plane as well as standard school arithmetic, algebra and trigonometry. The books have also statistics and probability, functions as distinct from relations, inequalities and simple three dimensional problems including plans and elevation.

Except for a few topics like number and numeration systems the overall approach is that of the Entebbe books, formal axiomatic with rigor introduced in early stages. An interesting feature of the books is that of combining the different approaches to the introduction of geometry of the two syllabuses. In the earlier books, you find both of the topics of congruence and similarity of triangles as well as parallelograms, angle properties emphasizing spatial relationships like the SMP books. However, later work in geometry is presented like that of the Entebbe mathematics books.

Unlike Entebbe, in which the books in form 1 - 3 appear in two volumes of algebra and geometry separately, the books of the 1976 syllabus have both algebra and geometry. However, the books for 1976 syllabus for form 1 - 2 appear in two parts, each part having both algebra and geometry. There is one book for form 3 and form 4. Except for a few omissions of some parts of the Entebbe Book 4, the 1976 Book 4 looks very similar to the Entebbe Book 4.

We now discuss the chapter on the introduction to graphing in the number plane in Book 2, part 2. The subtopics discussed in this chapter are the number plane, graphs as pictures of truth sets, the intercept on the y-axis, the slope of the straight line and linear equations in two variables.

The chapter starts by introducing the number plane, ordered pairs, axes and origin very formally. For example, with reference to the diagram presented in the book of a coordinate plane with two points A(2,4) and B(-3,-2) shown on the plane, the number plane is introduced as follows:

> Suppose we have two number lines, intersecting at right angles as shown in the diagram above; we call this a number plane. We shall agree that the horizontal number line is the first, and the vertical one second. What is the first number that goes with A? The pair of numbers that correspond to B are (-3,-2).

Likewise, other subtopics are represented in the same manner. They discuss the graphs as pictures of truth sets, in which students are required to find the truth set of the sentence $-3 < x < 5$, if the domain of x is the set of integers, and to draw a picture of the truth set on a number line. Then they are asked to repeat the procedure for the domain of x as the set of real numbers. After this activity, students are asked to find the truth set of $y = x + 3$ in terms of ordered pairs to determine the relationship between these and the graph of the equation.

Once again, as with the Entebbe books, we see that the books for this syllabus put emphasis on formal mathematics. The idea is to present mathematics in terms of its structure and mathematics concepts discovered from this. Also, the ideas are presented from pure mathematics and a few applications given in the exercises. Thus the relationship between mathematics and real life and other disciplines is not seen in the books.

From the students' point of view, the materials demand early conceptualization, of which an average student is incapable. Also, the reduced emphasis on the applications of mathematics cause many students to view mathematics as a hard subject and thus come to hate it. Furthermore, inherent in over -formalized teaching of mathematics is the introduction of elitism in the society. Finally, the books make more work for the teachers. First, because of the inherent difficulties of trying to use two different approaches (SMP and Entebbe) to teaching mathematics and also trying to preserve the Entebbe approach but reducing words. The latter difficulty is very much seen in the presentation of the topic above. The students are not given enough activities to discover the concepts needed. As with the Entebbe books, the books make more demand on teachers' mathematical background. Teachers are expected to introduce the topics in their own words or approach and to present more exercises on the applications of mathematics.

Analysis of the National mathematics syllabus 1988

This is a revised secondary school mathematics syllabus which is a result of the evaluation of the teaching of secondary school mathematics which was done in 1981 by the Institute of Education. The following are the changes as specified in the syllabus which can be noticed as compared to that of 1976:

1. The specific objectives for each form have been identified.
2. The syllabus has been written formwise with topics and subtopics arranged in a logical sequence.
3. The subtopics, objectives teaching/learning activities and reference/teaching aids have been stated for every topic.

The broad objectives of teaching secondary mathematics in Tanzania are the same as those stated in the 1976 syllabus, except for the fourth objective. The content of the syllabus is the same, with the exception of simple book-keeping which was in the 1976 syllabus. The specific objectives, as defined for each form or topic, are operational. For example for the topic of fractions, the specific objectives are that the pupil should be able to:

1. identify proper and improper fractions and mixed numbers.
2. simplify a fraction to its lowest terms.
3. compare fractions.

A further look at the syllabus indicates the nature of school mathematics as viewed by the curriculum developers. The syllabus contrasts very much with the former syllabuses (SMP, Entebbe, National 1976) in that it emphasizes the techniques of mathematics facts and skills, unlike the former which emphasize the understanding of the structure of mathematics. Throughout the syllabus the emphasis tends to be on the mastery of facts and techniques. For example, with respect to percentages one of the teaching and learning activities as proposed by the syllabus, is that the pupils should do many examples and exercises on changing percentages into fractions and decimals and vice versa. In general, the emphasis seems to be on the "how" of mathematics. Clearly we can see the developers' view of mathematics as a clear body of knowledge and techniques made up of facts and skills.

It can be seen from above that the major goal is competence in basic mathematics skills. Therefore, the relationship of mathematics to other disciplines and its applications is of little importance. Also, the role of the teacher is to show and tell and to diagnose errors and prescribe remediation for the students. This is very prominent in the teaching and learning activities proposed by the syllabus. The role of students is to replicate that which they have been shown and told.

Analysis of the textbooks for the National syllabus of 1988

The books for the syllabus of 1988 appear in single volumes from form 1 - 4. There is no difference between the content of mathematics in these books and that of 1976. However, the general trend in the books seems to be emphasizing mathematical skills and presenting mathematics.

Let us examine the chapter on coordinate geometry as presented in Book 1 in this series. The subtopics presented under this topic are coordinates of a point, gradient of a straight line, drawing graphs of linear equations and solving linear simultaneous equations graphically. First, the topic is introduced by the definitions of a number plane, the axes, and an ordered pair. The definitions are presented as mathematical facts or information. For example, the number plane is defined as "a number plane is made up of two lines intersecting at right angles as shown in the figure (a figure of a coordinate plane is presented). The axes are defined as "the horizontal line is called the x-axis and the vertical line is called the y-axis". The examples of finding points in a coordinate plane are given and similar exercises given.

A similar approach is used to present the subtopics in this chapter. The gradient of a line is defined and then examples of how to find the gradient of the line and similar exercises are given. The method of finding the equation of a line is presented and examples on how to draw a graph of linear equations are given and similar exercises presented.

As can be seen from the above, unlike the other books for the other syllabuses (SMP, Entebbe and National 1976), the books for this syllabus emphasize skills and mathematics facts. The definitions for the concepts are given as the definition of number plane and an example on how to perform a certain skill is given, for example, how to find the gradient of the line. Also, no reference is given on applications of mathematics to real life or other disciplines except for a few cases.

As discussed in relation to the syllabus, implicitly the image of the learner as presented in these books is that of a passive recipient. The role of the students is to memorise the facts given and replicate that which they have been shown by the examples given.

The relationship of mathematics and society is that it is expected that the students will learn the basic skills and be able to apply them in future work. This approach demands from the teacher the ability to plan lessons in a much more meaningful way in order to discourage rote learning.

<u>Summary</u>

In general the four syllabuses can be summarised as follows. The SMP, Entebbe and the National syllabus of 1976 share three basic assumptions about mathematics. First mathematics is considered to be a closed system, independent of other subjects, and in which most concepts serve as prerequisites for concepts to be learned in later levels. The second assumption is that set theory can be used to unify mathematics. The third assumption is that emphasis on the structure of mathematics can be the focus of mathematics learning and teaching. While these three syllabuses share assumptions, their approaches differ. The primary instructional goal for SMP is teaching for understanding of concepts and relationships from pupils' familiar experiences. The primary instructional goal for Entebbe and the National syllabus of 1976 is teaching for logical precision.

The underlying assumption about mathematics implicit in the National syllabus of 1988 is that mathematics is a body of facts and techniques. The primary instructional goal is teaching for mastery of skills.

Curriculum organization for the SMP is spiral. That of the Entebbe and the National syllabus of 1976 is axiomatic, with some elements of a spiral. Curriculum organisation for the National syllabus of 1988 is that of a structured and sequential hierarchy. The teachers' role implicit in the SMP, Entebbe and the National syllabus of 1976 is that of a communicator of concepts. The syllabuses demand from the teacher knowledge of the content sufficient to generate varied examples. The teachers' role implicit in the National syllabus of 1988 is that of diagnostician and prescriptor. Minimum content knowledge is required of the teacher.

CHAPTER 5

FINDINGS FROM THE TEACHERS' QUESTIONNAIRE

This chapter is divided into two major sections. In section one the findings from the teachers' questionnaire are presented together with some brief discussion of the key points derived from the findings. The information derived from the teachers' questionnaire is presented in five sections:

1. Background of the teachers and overview information
2. Content
3. Planning and approaches to teaching
4. Assessment of time, students' performance and obstacles.
4. Recommendations.

In section two of the chapter, the teachers' views about the mathematics program are discussed by focusing them to the research questions.

Background of the teachers and overview information

Background of teachers

Of the total sample of 18 teachers who participated in this study, 13 are males and 5 are females. All of them were above 26 years of age, with 66.7% being in the age range of 26-35 years, 27.8% in the age range of 36-45 years and one teacher (5.6%) in the age range of 46-55 years.

Twelve teachers (66.7%) had a Diploma in Education as their professional qualification, with eight (44.4%) graduating from Dar-es-Salaam College of National Education, three (16.7%) from Mkwawa College of National Education, and one (5.6%) from University of Leeds. Six teachers (33.3%) had Bachelor of Science (Education) degree, all of them from University of Dar-es-Salaam. All teachers have teaching experience of more than 2 years. Four teachers (22.2%) in the range of 2-5 years, eight teachers (44.4%) in the range of 6-9 years, three (16.7%) in the range of 10-13 years and three (16.7%) in the range of 14 years and above. Nine teachers (50%) teach in girls' secondary schools, six (33.3%) teach in co-education secondary schools and three (16.7%) teach in boys' secondary schools. The majority of the teachers (72.2%) have physics as their second teaching subject. Three teachers (16.7%) have chemistry as their second teaching subject, one teacher (5.6%) has biology and one (5.6%) has only mathematics as his teaching subject. Thirteen teachers (72.2%) were teaching only one subject at the time this questionnaire was administered and five (27.8%) were teaching two subjects. Fourteen of the teachers (77.8%) were teaching more than 100 different students and four (22.2%) were teaching fewer than 59 different students. Most of the teachers had their mathematics teaching load distributed equally between two forms. Two teachers had their mathematics teaching load allocated to only one form and one teacher had his mathematics teaching load distributed among three forms, 40% in each of the two (form 1 and form 3) and 20% in form 2.

Most of the teachers (94.4%) rated the adequacy of their background for implementing the overall goals of secondary mathematics in Tanzania as satisfactory or good or very good. Only one teacher (5.6%) regarded the adequacy of his background as unsatisfactory.

An Overview Information

Fourteen of the teachers (77.8%) indicated that they usually teach ordinary level and the other four (22.2%) teach advanced level. Most of the teachers (83.3%) indicated the National Secondary Mathematics syllabus of 1976 as the syllabus they used when they started teaching. One teacher (5.6%) indicated the Entebbe Mathematics syllabus, one (5.6%), the School Mathematics Project of East

Africa and one (5.6%) the National Secondary Mathematics syllabus of 1988. All teachers indicated that the syllabus they started teaching had changed. Nine teachers (50%) indicated head of school or staff meetings as the means by which the new syllabuses were communicated to them. Four (22.2%) indicated education circulars, two (11.1%) indicated informal talks with other teachers, one (5.6%) indicated attendance at inservice courses, and one teacher (5.6%) indicated that buying new syllabuses from shops as the means by which the new syllabus was communicated to him. Eight teachers (44.4%) were of the opinion that education circulars were the common method by which new syllabuses are communicated to teachers. Six teachers (33.3%) were of the opinion that other methods, including attendance at Mathematics Association of Tanzania (MAT) meetings, buying new syllabuses from shops, and head of department meetings were common methods by which new syllabuses were communicated to teachers. Two (11.1%) indicated informal talks with other teachers, one (5.6%) indicated attendance at inservice courses, and one (5.6%) indicated the head of school or staff meetings as the common method by which new syllabuses are communicated to teachers.

All teachers identified the Tanzanian secondary mathematics books issued by the Ministry of Education for the syllabus of 1976 and those issued by the Institute of Curriculum Development for the syllabus of 1988 as books used for teaching and learning mathematics. Of the eighteen teachers, only eight indicated that they had attended workshop meetings or seminars in connection with the teaching of mathematics. Six teachers out of eight indicated that the seminars they had attended were conducted by the Mathematics Association of Tanzania (MAT) where difficult topics were discussed. One teacher attended the seminars conducted by the Institute of Curriculum Development for the writing of the books for the syllabus of

1988.

Key Points

1. The majority of teachers who participated in this questionnaire teach O'level secondary mathematics.
2. Most of the teachers indicated the National Secondary Mathematics Syllabus of 1976 as the syllabus they used when they started teaching.
3. The majority of teachers indicated head of school or staff meetings as the means by which new syllabuses were communicated to them.
4. A significant number of teachers were of the opinion that education circulars were the common method by which new syllabuses were communicated to teachers.
5. Books used for teaching and learning are the Tanzanian secondary mathematics Books issued by the Ministry of Education and the Institute of Curriculum Development.
6. The majority of teachers who participated in this questionnaire had not attended any workshops or seminars in connection with mathematics teaching. Most of the seminars or workshops attended by a few teachers were conducted by Mathematics Association of Tanzania (MAT) in which the issue of difficult topics was discussed.

Discussion

An examination of the findings presented above suggest the following points worth noting. The first point deals with the question of the implementation of curriculum reform. Most of the teachers in this study indicated the syllabus of 1976 as the syllabus they used when they started teaching. This means that most of them were involved in the implementation of the new syllabus of 1988. The majority of teachers indicated that they had not attended any seminars or workshops in connection with mathematics teaching. Only a few teachers indicated that they had attended seminars conducted by the Mathematics Association of Tanzania (MAT) in which difficult topics were discussed. This observation suggests that there were no inservice courses conducted by the Ministry of Education or the Institute of Curriculum development in connection with the implementation of the new syllabus. This means that the only way teachers were involved in the implementation process is through the textbooks and syllabuses communicated to them either through the head of school or staff meetings as the findings suggest. It is very likely from this observation that teachers may rely on textbooks in their teaching.

Another point worth noting is the nature of seminars or work shops conducted by the Mathematics Association of Tanzania. Issues discussed are difficult topics.

The content

In question 8, part two of the teachers' questionnaire, teachers were presented with the list of topics for each form that appears in the ordinary secondary mathematics syllabus of 1988. They were asked to rate both the importance and the difficulty for the students as well as the interest in teaching of each of the topics, the teachers in their schools find. Responses to the topics were made on a four-point Likert scale ranging from very important/very difficult/very interesting to not important/not difficult/not interesting. These points were summed up for each topic and the mean score calculated to indicate the relative importance, difficulty and interest of each topic.

<u>Form one</u>

The rank order together with the mean scores for the importance, difficulty and interest of form one topics are shown in Table 1. In general there is a high degree of consensus among the teachers that all the topics listed for form one students are important for them. The range of the

Table 1

The Rank Orders of Form One Topics as perceived by Teachers to be Important and Difficult for the Students and Interesting to Teach.

	Topic	Importance		Difficulty		Interest	
		Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	Numbers	1.167	(1)	2.938	(13)	1.688	(2)
2.	Percentages	1.278	(2)	3.000	(14)	2.125	(8)
3.	Fractions	1.278	(2)	2.625	(11)	1.938	(3)
4.	Geometry	1.333	(4)	2.375	(7)	2.375	(13)
5.	Decimals	1.389	(5)	2.438	(9)	2.063	(7)
6.	Units	1.444	(6)	2.313	(5)	2.188	(9)
7.	Perimeter and areas	1.500	(7)	2.625	(11)	1.938	(3)
8.	Ratio and Rate	1.500	(7)	2.125	(2)	1.938	(3)
9.	Algebra	1.556	(9)	2.375	(7)	1.625	(1)
10.	Coordinate Geometry	1.667	(10)	2.125	(2)	1.938	(3)
11.	Statistics	1.889	(11)	2.438	(9)	2.250	(11)
12.	Approximation and accuracy	1.889	(11)	1.750	(1)	2.750	(14)
13.	Real Numbers	1.944	(13)	2.313	(5)	2.188	(9)
14.	Variation	2.000	(14)	2.188	(4)	2.250	(11)

mean scores for all topics was 1.167 to 2.000 indicating that all topics are fairly or very important. An extremely important topic for form one as perceived by teachers is numbers. Then percentages and fractions are ranked second. These are followed by geometry, decimals and units. Perimeters and areas and ratio and rate are ranked seventh followed by algebra and coordinate geometry. Statistics and approximation and accuracy are ranked eleventh followed by real numbers. The least important topic for form one as perceived by teachers is variation. A close look on the topics shows that all topics of number nature except real numbers are perceived to be important for form one students. Numbers, percentages, fractions, and decimals occupy the first five places in the rank order. Also, topics which have strong appeal to practical application are perceived to be relatively the least important. These are statistics, approximation and accuracy and variation.

There appears to be a high degree of consensus among teachers also that the majority of topics listed for form one are fairly difficult for the students. The range of the mean scores is 1.750 to 2.938, indicating that all topics are fairly or of little difficulty for the students. The most difficult topic for form one students, as perceived by teachers, is approximation and accuracy. Then ratio and rate and coordinate geometry are ranked second followed by variation. Geometry and algebra are ranked seventh and decimals and statistics are ranked ninth, followed by perimeters and areas and fractions getting the eleventh place. These are followed by numbers. The least difficult topic is percentages. The data also reveal that topics of number nature, with the exception of real numbers, are perceived by teachers as of little difficulty for the students. Decimals, fractions, percentages, and numbers are rated the least difficult.

The mean scores of the responses for the "interest in teaching" of form one topics reveal that teachers enjoy teaching most of the topics in form one. The range of the mean scores for the interest is between 1.625 and 2.750, indicating that the topics are fairly interesting to teach. The most interesting topic to teach, as perceived by teachers, is algebra followed by numbers. Fractions, perimeters and areas, ratio and rate, and coordinate geometry are ranked third. These are followed by decimals, then percentages followed by units and real numbers. Among the least rated topics are statistics and variation, geometry and approximation and accuracy.

An examination of the data on form one topics suggests the following relationships between the importance, difficulty and interest in teaching of the topics. First, there are those topics which are perceived as the most important and less difficult for the students and also the most interesting to teach. These are topics of number nature, that is, numbers, percentages, fractions and decimals. Second, there are those topics which are perceived as the least important and most difficult for the students and also the least interesting to teach. These are approximation and accuracy, real numbers and variation.

Form two

The rank orders, together with the mean scores for the importance, difficulty, and interest of form two topics are shown in Table 2. The data suggests a high degree of consensus among the teachers that all topics listed in the syllabus for form two are important for them. The range of the mean scores for importance of the topics is between 1.188 and 2.000, indicating that all topics are fairly or very important for the students. An examination of the data, with respect to the relative importance of the topics, shows that Pythagoras Theorem and logarithms are the most important topics for form two students. Then of second

Table 2
The Rank Orders of Form Two Topics as Perceived by Teachers to be Important and Difficult for Students and Interesting to Teach.

Topic		Importance Mean score	Rank	Difficulty Mean score	Rank	Interest Mean score	Rank
1.	Pythagoras Theorem	1.188	(1)	2.563	(7)	1.313	(1)
2.	Logarithms	1.188	(1)	2.313	(5)	1.500	(3)
3.	Algebraic expressions and equations	1.313	(3)	2.625	(10)	1.938	(6)
4.	Quadratic Equations	1.313	(3)	2.563	(7)	1.313	(1)
5.	Exponents	1.313	(3)	2.875	(13)	1.563	(4)
6.	Trigonometric ratios	1.313	(3)	2.125	(4)	2.063	(7)
7.	Sets	1.313	(3)	2.688	(11)	1.563	(4)
8.	Similarity	1.500	(8)	2.063	(2)	2.188	(9)
9.	Radicals	1.563	(9)	2.750	(12)	2.063	(7)
10.	Vectors	1.625	(10)	2.375	(6)	2.563	(10)
11.	Congruence	1.688	(11)	1.938	(1)	2.750	(12)
12.	Enlargement	1.875	(12)	2.563	(7)	2.750	(12)
13.	Locus	2.000	(13)	2.063	(2)	2.563	(10)

importance are algebraic expressions and equations, quadratic equations, exponents, trigonometric ratios and sets. The topics which are perceived to be of relatively least importance arranged in descending order of their importance are similarity, radicals, vectors, congruence, enlargement and locus. The range for the mean scores for the difficulty of the topics was between 1.938 and 2.875, indicating that the topics are perceived by teachers as fairly or of little difficulty for the students. The most difficult topics, in descending order of their difficulty, are congruence, locus and similarity then trigonometric ratios. The topics that are of relatively medium difficulty in descending order of their difficulty are logarithms, vectors, and pythagoras theorem and quadratic equations and enlargement. The least difficult topics are algebraic expressions and equations, sets, radicals and then exponents.

The data on the "interest in teaching", as perceived by teachers, suggest that teachers find most of the topics interesting to teach. The range of scores for the interest in topics is between 1.313 and 2.750. The means for the most of the topics are between 1.313 and 2.063, indicating that teachers perceive most of the topics as fairly or very interesting to teach. A close look at the relative interest in teaching the topics shows that the most interesting topics to teach, in descending order, are pythagoras theorem and quadratic equations, logarithms and then exponents and sets. Then those of medium interest in descending order, are algebraic expressions and equations, trigonometric ratios and radicals and then similarity. The least interesting topics to teach, as perceived by teachers, in descending order of their interest are vectors and locus and then congruence and enlargement.

A further examination of the data reveals that most of the topics which are perceived to be the least important are also perceived the least interesting to teach and the most difficult for the students. Vectors, congruence, enlargement and locus are the least important topics and they are also the least interesting topics to teach. Moreover, congruence and locus are the most difficult topics for the students. Also, the data suggests that the most important topics are the most interesting topics to teach. Pythagoras theorem and logarithms are the most important topics and they are also the most interesting to teach. They are perceived to be of medium difficulty for the students.

<u>Form three</u>

The rank orders, together with the mean scores for the importance, difficulty and interest of form three topics, are shown in Table 3. The data suggest a high degree of consensus among teachers that all topics listed for form three are important for the students. The range of the mean scores of importance of the topics was between 1.313 and 1.750 indicating that the topics are perceived by teachers as very or fairly important for the students. However, relatively the most important topics are kinematics and sequences and series. Of medium importance, in descending order of their importance, are statistics and then relations. The least important topics, in descending order of their importance, are circles, spheres and then functions and plan and elevation.

A close look at the data shows that all of the topics which are rated low in importance except functions are those which appeal to geometry. These are circles, spheres and plan and elevation.

The data on the difficulty of the topics for students indicate that teachers find the topics fairly difficult for the students. The range of the mean scores for the difficulty of the topics is between 2.125 and 2.500.

Table 3

The Rank Orders of Form Three Topics as Perceived by Teachers to be Important and Difficult for the Students and Interesting to Teach

	Topic	Importance		Difficulty		Interest	
		Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	Kinematics	1.313	(1)	2.250	(3)	2.188	(3)
2.	Sequences and Series	1.313	(1)	2.125	(1)	1.625	(1)
3.	Statistics	1.438	(2)	2.500	(7)	1.688	(2)
4.	Relations	1.563	(3)	2.438	(6)	2.375	(5)
5.	Circles	1.625	(4)	2.313	(4)	2.563	(7)
6.	Spheres	1.688	(5)	2.250	(3)	2.563	(7)
7.	Functions	1.750	(6)	2.188	(2)	2.250	(4)
8.	Plan and Elevation	1.750	(6)	2.375	(5)	2.500	(6)

Relatively the most difficult topics, in descending order, are sequences and series, functions, and then kinematics and spheres followed by circles. The least difficult topics, in descending order, are plan and elevation, relations and statistics.

The range of mean scores for the interest in teaching the topics is between 1.625 and 2.563, indicating that teachers perceive the topics listed for form three as fairly or very interesting to teach. Relatively, the most interesting topics to teach as perceived by teachers are sequences and series and statistics. The topics which are perceived to be of medium interest, in descending order of their interest, are kinematics, functions, and relations. The least interesting topics are, in descending order of their interest, plan and elevation and then circles and spheres.

Further examination of the data suggests that most of the topics which are perceived as the most important are also perceived as the most interesting to teach. Kinematics, sequences and series, statistics and relations are the most important topics as well as the most interesting topics to teach as perceived by teachers. However, kinematics and sequences and series are the most difficult topics for the students and statistics and relations the least difficult topics. Also, many of the topics which are perceived to be least important are also perceived as the least interesting to teach. Circles, spheres, functions and plan and elevation are the least important topics and all except functions are the least interesting topics to teach. Functions is of medium interest to teach. Moreover, functions, spheres and circles are perceived as the most difficult topics for the students.

<u>Form four</u>

The rank order, together with the mean scores for the importance, difficulty and interest of form four topics are shown on Table 4. The data indicate that all the topics listed for form four students are very or fairly important for the students. The range of the mean scores is between 1.313 and 1.875. However, relatively, an extremely important topic is areas and volumes. Then, of medium importance, are coordinate geometry, linear programming and vectors. The least important topics are in descending order of their importance, matrices and transformation, three dimensional geometry and then probability.

The data on difficulty of the topics for the students indicate that teachers perceive the topics as fairly difficult or of little difficulty for the students. The range of the mean scores for the difficulty of the topics was between 2.467 and 2.733. Relatively the most difficult topic for form four students as perceived by teachers are linear programming and vectors. These are followed by trigonometry, matrices and transformation, then three dimensional geometry and probability. The least difficult topics are areas and volumes and coordinate geometry.

The range of the mean scores for "interest in teaching" of most of the topics listed for form four is between 1.438 and 2.000 indicating that teachers perceive most of the topics as very or fairly interesting to teach. The most interesting topic to teach is coordinate geometry. Of medium interest in descending order of their interest are, matrices and transformation, and then areas and volumes and linear programming. The least interesting topics to teach in descending order of their interest are trigonometry and vectors, probability and then three-dimensional geometry.

The data also reveal that topics which are perceived to be the most important for the students are also perceived as the most interesting to teach and least difficult for the students. Areas and volumes and coordinate geometry are relatively the most important, the least difficult and the

Table 4
The Rank Orders of Form Four Topics as Perceived by Teachers to be Important and Difficult for the Students and Interesting to Teach.

	Topic	Importance Mean score	Importance Rank	Difficulty Mean score	Difficulty Rank	Interest Mean score	Interest Rank
1.	Areas and Volumes	1.313	(1)	2.733	(5)	1.875	(3)
2.	Coordinate Geometry	1.438	(2)	2.733	(5)	1.438	(1)
3.	Linear Programming	1.438	(2)	2.467	(1)	1.875	(3)
4.	Trigonometry	1.438	(2)	2.533	(2)	2.000	(4)
5.	Vectors	1.500	(3)	2.467	(1)	2.000	(4)
6.	Matrices and Transformation	1.750	(4)	2.600	(3)	1.813	(2)
7.	Three Dimensional Geometry	1.813	(5)	2.667	(4)	2.938	(6)
8.	Probability	1.875	(6)	2.667	(4)	2.375	(5)

most interesting topic to teach. Also three-dimensional geometry and probability are relatively the least important topics, of medium difficulty and the least interesting to teach.

Across the forms

An examination of the topics which are met in different forms shows the following patterns. The topic of statistics is perceived as the least important, the least difficult and the least interesting to teach for form one students, but teachers perceive it as among the most important topics, the least difficult and the most interesting to teach for form three students. Coordinate geometry is perceived as of medium importance, the most difficult and an interesting topic to teach for form one students, but the most important, least difficult and the most interesting to teach for form four students. Also topics for form four students are perceived to be relatively less difficult for the students.

Key Points

1. There was a high degree of consensus among teachers that all topics in the curriculum are important for the students.
2. Teachers were of the opinion that the topics in the curriculum are fairly or of little difficulty for the students.
3. There was an indication that teachers find most of the topics interesting to teach.
4. Except for a few cases, most of the topics which were considered as the least important were those which appeal to direct practical application; for example, statistics, approximation and accuracy and variation for form one, plan and elevation for form three and three-dimensional geometry and probability for form two.

5. In some cases where the topics which appeal to practical application were considered the most important, they were also perceived as the most difficult for the students but the most interesting to teach. Examples are kinematics for form three and linear programming for form four.
6. There is an indication that topics which are perceived as the most important, are also the least difficult for students and the most interesting to teach. Also, topics which are perceived the least important, are also perceived to be the most difficult for the students and the least interesting to teach.

Discussion

The following are the points worth noting in regard to the teachers' views about the content of school mathematics. The high degree of consensus among teachers that all topics listed in the syllabus are important for them seems to suggest the following. First, most of the mathematics teachers accept the restricted view of mathematics content as the list of topics in the syllabus and probably more specifically that which they themselves experienced as students. Secondly, it seems that the question of importance or purpose of mathematics to students is of little concern for many teachers.

Further examination of the key points and the observations concerning the relative importance and difficulty for the students and the interest in teaching, the teachers assign to the topics suggests the following implications. The observation that most of the topics which are perceived as the most important, are also the least difficult for students and the most interesting to teach can mean the following concerns of teachers in their teaching. First, what teachers think is important for the student is what students find easy and therefore can achieve well.

Secondly, teachers are concerned with the 'smoothness' of their lesson and therefore a lesson in which students find the subject easy is likely to be enjoyable.

The findings indicate that most of the topics which teachers perceive as the least important are those which appeal to direct application. And as we have seen from above, these are topics which students find difficult and teachers perceive to be the least interesting to teach as well. Two things can be derived from this observation. One has to do with the nature of school mathematics, as perceived by teachers, and the other with their methods of teaching. It seems that teachers perceive school mathematics as a self-contained body of established knowledge and procedure - facts and rules. Therefore, any mathematics content requiring activities beyond this, for example, relating to real life, is considered not very important. It is very likely from this that, in most mathematics lessons, students are taught rules, technical notations and established conventions of mathematics without acquiring any feeling for why these systems exist. Thus, even though the topics appeal to applications, they are treated in a superficial way or in such a way that students can not understand them and therefore find them difficult.

Planning and approaches to teaching

Teaching methods

In question nine, Part 2, of the questionnaire, teachers were asked to indicate how frequently mathematics teachers in their schools use particular methods in their teaching of mathematics. The teachers were presented with ten teaching methods and asked to rate them according to a five point scale. The percentage of teachers rating each point is shown in Table 5.

The teaching methods which were rated by the majority of teachers as "never used", arranged in decreasing order of the percentage of assessment, are

1. Student directed class discussion
2. Inquiry based activities
3. Small group activities
4. Lectures
5. Teacher demonstration

The majority of teachers (50.0%) report that tests or quizzes are used about once or twice during the unit. A significant number of teachers (38.9%) indicated that student boardwork method is used about once or twice during the week.

Teaching methods which were rated highest as used by teachers almost every class period, arranged in order of their percentages of assessment are

1. Teacher boardwork
2. Have students practice problems independently
3. Class discussion teacher/class dialogue.

Handling completed homework

In question 10 of Part 2 of the questionnaire, teachers were asked to indicate how frequently mathematics teachers in their schools use a particular method in handling completed homework, using a five point scale. The percentages of teachers assessing each point is shown in Table 6.

The majority of teachers (50%) who responded to this part indicated that their colleagues collect homework to mark personally about once or twice during the week. The majority of teachers (61.1%) also indicated that teachers discuss difficult questions almost every class period. Fifty percent of the teachers indicated that their colleagues record a mark of student performance about once or twice during the week.

The methods which were rated by a significant number of teachers as "never used" are (arranged in decreasing order

Table 5

Percentage of teachers Assessing the Teaching Methods

According to Frequency

	Method	n	ASSESSMENT				
			Never	About once or twice during the unit.	About once or twice during the week	Almost every class period	Other (Rarely)
1.	Lectures	18	61.1	16.7	11.1	11.1	0.0
2.	Teacher demonstration	18	50.0	38.9	5.6	0.0	0.0
3.	Class discussion teacher/class dialogue	18	5.6	16.7	27.8	44.4	5.6
4.	Small group activities	18	66.7	16.7	11.1	0.0	5.6
5.	Student directed class discussion	18	83.3	11.1	5.6	0.0	0.0
6.	Have students practice problems independently	18	5.6	5.6	33.3	55.6	0.0
7.	Teacher boardwork	18	5.6	5.6	5.6	83.3	0.0
8.	Student boardwork	18	22.2	16.7	38.9	16.7	5.6
9.	Inquiry based activities	18	72.2	5.6	5.6	5.6	11.1
10.	Tests or quizzes	18	11.1	50.0	22.2	16.7	0.0

Table 6

Percentage of Teachers Assessing Methods of Handling Homework

According to Frequency

Method	n	ASSESSMENT				
		Never	About once or twice during the unit	About once or twice during the week	Almost every class period	Other (Rare)
1. Collect it to mark it personally	18	11.1	27.8	50.0	11.1	0.0
2. Read answers in class	18	44.4	33.3	5.6	16.7	0.0
3. Display answers in class	18	38.9	11.1	22.2	11.1	11.1
4. Display answers and methods in class	18	38.9	22.2	16.7	22.2	0.0
5. Discuss difficult questions	18	0.0	22.2	16.7	61.1	0.0
6. Have students discuss methods	18	50.0	22.2	11.1	16.7	0.0
7. Record a mark of student performance	18	5.6	50.0	22.2	16.7	5.6

of percentages of assessment)

1. Have stüdents discuss methods.
2. Read answers in class.
3. Display answers in class.
4. Display answers and methods in class.

Planning mathematics lessons

In question 11 of Part 2, teachers were asked to indicate how certain factors influence mathematics teachers in their schools in planning mathematics lessons. Teachers were presented with a list of factors and asked to respond using a five point scale of probably the most influence (1) to no influence (5). The points were summed up for each factor and the mean score calculated to indicate the relative influence of each topic. The mean score and rank orders for the factors are shown in Table 7.

In general, teachers perceived most of the factors as of significant influence. The range of the mean score for the factors is between 1.833 and 3.833. The strongest influence as perceived by teachers, is "approaches that ' worked well for them". The factors which are perceive teacher as of medium influence, in descending order of influence, are: "the material builds on or extends co covered in previous grades", "the students' ability" an "their (teachers) interests, background and preferences", "the time available", "what students find easy to understand", then "what students will enjoy and find personally interesting". Factors which are perceived by teachers as of weak influence are: "what society needs by way of informed citizen" and "what students require in order to understand the historical development of mathematics".

Prioritizing lesson objectives

In question 12 of Part 2 of the questionnaire, teachers were asked to rank the factors influencing teachers in prioritizing their lesson objectives, using a five point

Table 7

The Rank Orders and Mean Scores for the Factors Influencing Teachers in Planning Their Lessons

Factor	Mean score	Rank
1. Approaches that have worked well for them in the past	1.833	(1)
2. The material builds on or extends concepts covered in previous grades.	2.056	(2)
3. The students' ability	2.222	(3)
4. Their interests, background and preferences.	2.222	(3)
5. The time available.	2.278	(5)
6. What students find easy to understand.	2.389	(6)
7. What students will enjoy and find personally interesting.	2.889	(7)
8. What society needs by way of informed citizen.	3.611	(8)
9. What students require in order to understand the historical development of mathematics.	3.833	(9)

scale from most influential (1) to least influential (5). The points were summed up on each factor and the mean score calculated to indicate the relative strength of the factors. The mean scores for each factor in each form are shown in Table 8.

There is a high degree of consensus among the teachers that all the factors listed influence teachers in prioritizing their lesson objectives. The range for the mean scores for all factors in all forms is between 1.500 and 2.500. The strongest influence for all forms in descending order of their influence are, "what students need to know to pass the examination", and "what the text book specifies". The second strongest factor for form two, three, and four is "what the syllabus specifies". The second strongest for form one is, "what students need to know to understand the structure of mathematics". The lowest ranked factors, in descending order of their influence for form one, are "what students need to know in their daily lives" and "what the syllabus specifies"; form two, "what students need to know to understand the structure of mathematics", "what students need to know in their daily lives"; form three and form four, "what students need to know in their daily lives", "what students need to know to understand the structure of mathematics".

Key Points

1. The most common teaching methods are teacher boardwork, having students practice problems independently and class discussion (teacher class dialogue).
2. The most uncommon methods are student directed class discussion, inquiry based activities, small group activities, lectures and teacher demonstration.
3. The majority of teachers use quizzes or tests about once or twice during the unit.
4. The majority of teachers collect homework to mark

Table 8

The Mean Scores for the Factors Influencing Teachers in Prioritizing Their Lesson Objectives

Factor	Mean Scores			
	Form 1	Form 2	Form 3	Form 4
1. What students need to know in their daily lives.	2.357	2.571	2.286	2.143
2. What students need to know to pass the examination.	1.786	1.643	1.643	1.500
3. What the syllabus specifies.	2.357	2.071	2.071	2.071
4. What the textbook specifies.	1.857	1.786	1.714	1.714
5. What students need to know to understand the structure of mathematics.	2.214	2.143	2.357	2.500

personally about once or twice a week and record a mark of students' performance. The majority also discuss difficult questions almost every class period.

5. The most influential factors affecting teachers in their planning of lessons are those of classroom experience nature. For example, "approaches that have worked well for them in the past". Factors outside classroom experience are not very influential. For example, "what society needs by way of an informed citizen".
6. Examinations, textbooks and syllabuses influence teachers in prioritizing their lesson objectives.

Discussion

An examination of the key points and findings reported in this section suggests the following points worth noting. It seems that the very common methods of teaching mathematics in secondary school are of "transmission - authoritative" nature. These include the teacher boardwork, having students practice problems independently and class discussion, that is, teacher-class dialogue. The characteristic features of these methods include the funnelling of classroom talk through the teacher in a question-answer pattern where selected pupils act as proxy representative for the whole class, and the teacher boardwork - seatwork pattern of a lesson. These findings tend to support the previous comments made with regard to how teachers assign importance of the topics for the students. It seems that there is a tendency for teachers to value those topics which lend themselves to these methods of teaching, that is, topics which lend themselves to facts to be memorised and procedures to be practised.

Further examination of the key points and observations reported in this section suggests other explanations for the observation given above. The influence of examinations on the teachers in prioritizing their lesson objectives can constrain teachers in their approach to teaching. Teaching for examination is likely to be favoured by the transmission type of teaching methods. Other factors also perceived by the teachers are the textbooks and the syllabus. These also favour the transmission type of teaching.

Assessment of time, students' performance and obstacles

Assessment of time

In order to assess the time allocated to the mathematics curriculum, the teachers were asked to indicate how the mathematics teachers in their respective schools find the time allocated to cover the mathematics curriculum for form 1 - 2 and form 3 - 4 using a three-point scale of "not sufficient," "just sufficient" and "more than sufficient." Out of 16 teachers who responded to this question, for the part of form 1 - 2, 81.3% of them indicated that the time was not sufficient, 18.8% indicated that it was just sufficient and none of them indicated that it was more than sufficient. Of those who responded for the part of form 3 - 4, 81.3% indicated that the time was just sufficient, 18.8% indicated that it was not sufficient and none of them indicated that it was more than sufficient.

All of the teachers who indicated that time was not sufficient, suggested five hours per week be allocated to the mathematics curriculum. Concerning the way in which the time allocated should be distributed for each maths lesson, half of them (50.0%) indicated 40 minutes per lesson and another half (50.0%) indicated 80 minutes per lesson.

Assessment of students' performance

In questions 16 and 17 of Part 2 of the questionnaire, teachers were asked to indicate the percentage of students who pass the Form Two National Examination and Form Four (Ordinary Level) National Examination in their schools. They were presented with six categories for each National Examination. The percentage of teachers assessing each category is shown in Table 9 and Table 10.

Teachers were also asked to comment on the performance of students in the examinations. Upon analyzing the comments two issues emerged: (1) the results were subject to standardised examinations and (2) the pass mark for the examinations is usually low. In general, the teachers have the opinion that many students fail the examinations. Of 14 comments provided, 10 indicated this opinion. Teachers also indicated reasons for the failure as follows:

Form Two Examination:

1. Lack of mathematics teachers
2. Lack of textbooks
3. Many students in mathematics classes so that teachers do not find time for weak students.
4. Long syllabus
5. Examinations not reflecting the syllabus
6. Students are not serious.

Form Four Examination:

1. Students do not show enough interest
2. Many students in mathematics classes so that teachers don't find time for weak students.
3. Students are not serious.
4. Students do not work hard.

The Obstacles

In question 1 of Part three of the questionnaire, teachers were asked to indicate how serious are the problems experienced by teachers in implementing the mathematics curriculum. The percentages of teachers assessing the problems as "extremely serious" or "very serious" is presented in Table 11.

Table 9
Percentage of teachers assessing the percentage of students who pass the Form Two National Examination

Percentage of students	Assessment
1. Less than 20%	5.6
2. 20% - 34%	11.1
3. 35% - 44%	11.1
4. 45% - 54%	33.3
5. 55% - 70%	5.6
6. more than 70%	33.3

Table 10
Percentage of teachers assessing the percentage of students who pass the Form Four Examination

Percentage of students	Assessment
1. Less than 20%	0.0
2. 20% - 34%	0.0
3. 35% - 44%	44.4
4. 45% - 54%	16.7
5. 55% - 70%	11.1
6. more than 70%	22.2

Table 11

Percentages of Teachers assessing the Problems as Extremely serious or very serious

	Problem	n	Assessment
1.	English as second language	18	83.3
2.	Insufficient teaching resources.	18	77.8
3.	Students background	18	72.2
4.	Lack of inservice courses.	18	66.7
5.	Language presented in textbooks.	18	61.1
6.	Overcrowdness in classrooms.	18	61.1
7.	Many topics in syllabuses.	18	55.6
8.	Classrooms not conducive for learning.	18	55.6
9.	Density of concept presented in textbooks.	18	50.0
10.	Abstractness of concepts in textbooks.	18	50.0
11.	Sequence of topics in syllabuses not conducive to learning.	18	50.0
12.	Social background of students.	18	44.4
13.	Difficult topics.	18	38.9
14.	Wide ability range of students.	18	27.8
15.	Inadequacy of time	18	22.2
16.	Time not utilized	18	22.2
17.	Misuse of teaching resources.	18	11.1
18.	Inappropriate topics.	18	11.1

The highest rated problem (83.3%) is that of English as second language to the students. The least rated (11.1%) is that of inappropriate topics. The four highest rated problems arranged in order of their percentages of assessment are:

1. English as a second language.
2. Insufficient teaching resources.
3. Students' poor background knowledge.
4. Lack of inservice courses.

The problems were then analyzed in terms of the categories which were presented in the questionnaire. The percentages of teachers assessing each category as extremely serious or very serious are shown on the Table 12.

Over 50% of the teachers assessed the problems of teachers, classrooms, students, and textbooks as extremely or very serious. The highest rated problem area was that of teachers. The lowest rated was time.

In question 2 of Part 3 of the questionnaire, teachers were asked to list the three most serious problems experienced by teachers in their schools in teaching mathematics. Table 13 shows the problems listed in order of their frequencies.

Problems which appeared with the three highest frequencies are:

1. Insufficient teaching resources.
2. Lack of inservice courses.
3. Overcrowdedness in classrooms

<u>Key points</u>

1. The time allocated to cover the mathematics curriculum for form 1 - 2 was assessed by the majority of teachers as not sufficient.
2. The time allocated to cover the mathematics curriculum for form 3 - 4 was assessed by the majority of teachers as sufficient.

Table 12

Percentages of Teachers Assessing Problem Categories as Extremely serious or very serious

	Problem category	Assessment
1.	Teacher concerns	66.7
2.	Classrooms	58.4
3.	Students concerns	56.9
4.	Textbook concerns	53.7
5.	Teaching resources	44.5
6.	Syllabuses	38.9
7.	Time	22.2

Table 13

The frequency of teachers assessing the problems as the most serious

	Problem	Frequencies
1.	Insufficient teaching resources.	11
2.	Lack of inservice courses.	7
3.	Overcrowdedness in classrooms.	6
4.	English as a second language to students.	5
5.	Students lack interest in the subject.	5
6.	Poor background of students.	4
7.	Heavy teaching load.	3
8.	Inadequacy of time.	3
9.	Shortage of teachers.	2
10.	Lack of teachers motivation.	2
11.	Social background of students.	1

3. It seems that many students fail the form 2 and form 4 National examinations. Among other reasons for failure, teachers think that students are not serious and do not work hard.
4. Other reasons given for failure of form 2 examinations are a long syllabus, examination not reflecting the syllabus and many students in classrooms in such a way that teachers don't find time for weak students.
5. Teachers experience a number of obstacles in implementing the curriculum. The most serious problems are;
   - (i) English as a second language
   - (ii) Insufficient teaching resources
   - (iii) Lack of inservice courses
   - (iv) Students' poor background knowledge
   - (v) Overcrowdedness in classroom.

<u>Discussion</u>

The failure of many students in the National examinations can be explained by the comments made in previous sections. These include the way mathematics seems to be taught in secondary schools. The teaching of facts and rules of mathematics to the students without meaning encourages them to learn by memorising the facts and rules and, since there is much to learn, their memories can not allow this and therefore they fail to recall them in examinations. This failure can lead to many students resigning from learning mathematics and therefore appear to be not serious or not working hard to the teachers.

Furthermore, the obstacles mentioned above can constrain teachers in their approach to teaching. For example, lack of inservice courses can inhibit their professional development. Overcrowdedness, and insufficient teaching resources can cause teachers to incline their teaching methods towards more control-centred transmission styles of teaching.

Recommendations

Reasons for teaching mathematics

In question 1 of Part four of the questionnaire, teachers were presented with 16 reasons for teaching mathematics in secondary schools. They were required to indicate the emphasis that should be given to each one of them, using a five-point scale ranging from much more emphasis (1) to much less emphasis (5). The points for each reason were summed up and the mean score calculated to indicate the relative strength of the reasons. The rank orders, together with the mean scores for the reasons, are shown in Table 14.

There is demonstrable consensus among teachers that the reasons listed should receive emphasis in the mathematics curriculum. The range for the mean scores was between 1.444 and 2.722. The most highly rated reasons are:

1. To develop skills for further studies.
2. To think logically
3. To solve problems in everyday life.

The least rated were

1. To preserve a traditional part of schooling.
2. To provide insights into mathematics as Man's abstracting of nature.
3. To provide insights into mathematics as expression of Man's intellect and of Man's historical development.
4. To convey an appreciation of mathematics as concerned with patterns, shapes and order.

In question 2 of Part four of the questionnaire, teachers were asked to list the three most important reasons for teaching mathematics. Reasons mentioned, in order of their frequencies, are shown in Table 15. The reasons which were identified with the highest frequency are

Table 14

The Rank order of reasons for Teaching Mathematics as Perceived by Teachers.

	Reasons	Mean Scores	Rank
1.	To develop skills for further studies.	1.444	(1)
2.	To think logically.	1.500	(2)
3.	To solve problems in everyday life.	1.556	(3)
4.	To teach skills necessary for continued work in mathematics.	1.833	(4)
5.	To provide skills to study science related subjects.	1.833	(4)
6.	To develop understanding of the structure of mathematics.	2.000	(6)
7.	To provide insights into mathematics as a way of thinking and communicating thought.	2.167	(7)
8.	To stimulate curiosity and intellectual excitement.	2.167	(7)
9.	To assure an adequate supply of scientists and engineers.	2.167	(7)
10.	To preserve students options with respect to potential careers and vocational choices.	2.278	(10)
11.	To convey an appreciation of mathematics as a deductive system.	2.389	(11)
12.	To gain skills necessary for employment.	2.500	(12)
13.	To preserve traditional part of schooling.	2.667	(13)
14.	To provide insights into		

Table 14 continued.....

mathematics as Man's abstracting of nature.	2.667	(13)
15. To provide insights into mathematics as expression of Man's intellect and of Man's historical development.	2.667	(13)
16. To convey an appreciation of mathematics as concerned with patterns, shapes and order.	2.722	(16)

Table 15

The Frequencies of Teachers assessing the Reasons of Teaching Mathematics as the Most Important

Reason	Frequency
1. To think logically	7
2. To solve problems in everyday life	7
3. To provide skills to study science related subjects.	5
4. To provide insights into mathematics as a way of thinking and communicating thought.	5
5. To develop skills for further studies.	4
6. To assure adequate supply of scientists and engineers.	4
7. To stimulate curiosity and intellectual excitement.	2
8. To preserve students options with respect to potential careers and vocational choices.	2
9. To gain skiils necessary for employment.	1
10. To teach skills necessary for continued work in mathematics.	1
11. To develop understanding of the structure of mathematics.	1
12. To convey an appreciation of mathematics as a deductive system.	1
13. To convey an appreciation of mathematics as concerned with patterns, shape and order.	1

1. To think logically.
2. To solve problems in everyday life.

Classroom orientations

In question 3 of Part 4 of the questionnaire, teachers were presented with some possible classroom orientations for the content of secondary mathematics in Tanzania and asked to indicate which one they would recommend using a five point scale. The percentage of teachers rating the orientations as strongly recommend or just recommend as well as undecided is shown in Table 16. A large number of teachers who responded to this question (50.0% and above) rated all the orientations except one as strongly or just recommend. The least rated one was for the teacher and students to spend class time dealing with non-routine, hard problems. A significant number of teachers (31.3%) were undecided with this orientation.

Resources

In question 4 of Part 4 of the questionnaire, teachers were presented with statements about resources for use in mathematics classrooms and asked to indicate the emphasis each one should receive using a five point scale ranging from much more emphasis (1) to much less emphasis (5). The points were summed up for each statement and the mean score for each statement calculated to indicate the relative emphasis each one of them should receive. The rank orders together with the mean scores for the statements are shown in Table 17.

There is a high degree of consensus among teachers that most of the statements should receive much more emphasis or somewhat more emphasis. The range of mean scores of seven out of nine statements is 1.438 to 1.938, indicating that these statements about resources should receive much more or somewhat more emphasis. Relatively, statements which are

Table 16

The percentage of teachers assessing the classroom orientation as strongly or just recommend and undecided

Classroom orientation	n	strongly or just recommend	Undecided
The mathematics curriculum should include opportunities for:			
1. for the teacher and students to spend class time on explanations and proofs that would reinforce accurate thinking.	16	87.5	6.3
2. for the teacher to show different symbolic ways for representing formulas and procedures.	16	81.3	12.5
3. for the students to develop skills in estimation and approximation.	16	81.3	18.8
4. for the students to express mathematical procedures and solutions to the teacher and other students.	16	81.3	18.8
5. for the teacher to spend time showing how different mathematics topics interact with other mathematical topics, such as trigonometry and similar triangles.	16	75.0	25.0
6. for the students to develop sense of numbers.	16	75.0	25.0
7. for the teacher to spend class time showing specific			

Table 16 continued....

	practical application of mathematics such as conservation of resources, constructing road etc.	16	68.8	25.0
8.	for calculators to be introduced in secondary schools but postponed until students have learned both the meaning of, and paper and pencil procedures for number computation.	16	68.8	12.5
9.	for time to be spend on students explaining in detail how they developed a solution to a problem.	16	62.5	31.3
10.	for the teacher to spend class time showing additional alternative solutions to problems.	16	62.5	31.3
11.	for the teacher and students to spend class time dealing with end of chapter word problems.	16	50.0	31.3
12.	for the teacher and students to spend class time dealing with non-routine, hard problems.	16	37.5	31.3

Table 17

The rank order of statements about resources perceived to receive emphasis by teachers.

Statements about resources	Mean Score	Rank
1. Students worksheets or workbooks should be included for drill and practice at the conclusion of each lesson.	1.438	(1)
2. Tests, homework and specific objectives should be included to encourage each student to attain specified competency level.	1.500	(2)
3. Diagrams should be emphasized in textbooks and other materials.	1.500	(2)
4. Short problem solving sections should be included after each mathematical topic is taught.	1.750	(4)
5. Physical materials, which the students can manipulate to help them to understand mathematical ideas should be included in many lessons.	1.813	(5)
6. Activities should be included that anticipate the class being divided into small groups.	1.938	(6)
7. Ideas or procedures should be developed through real life problems, situations or activities.	1.938	(6)
8. Detailed notes should be provided to guide the teacher in oral presentations of the lessons.	2.125	(8)
9. Only problems which students can answer quickly should be assigned.	3.250	(9)

rated high in emphasis are:

1. Students worksheets or workbooks should be included for drill and practice at the conclusion of each lesson.
2. Tests, homework and specific objectives should be included to encourage each student to attain specified competence level.
3. Diagrams should be emphasized in textbooks and other materials.

The lowest rated was, "only problems which students can answer quickly should be assigned".

Teaching Strategies

In question 5 of Part 4, teachers were presented with some teaching strategies and asked to indicate which ones they would recommend for use in mathematics classrooms. The percentage of teachers assessing the teaching strategies as strongly recommend or just recommend is presented in Table 18.The majority of teachers (50% and above) recommend the teaching strategies for use in mathematics classrooms. The most highly rated strategy is "when students are shown how to solve a problem and then similar practice problems are assigned". The least rated teaching strategy is "most lessons are designed to be conducted with a single large group".

Areas of improving secondary mathematics

In question 6 of part 4, teachers were asked to assign priorities for the attention to the broad areas of improving secondary mathematics in Tanzania. They were to do this using a five-point scale of highest priority (1) to lowest priority (5) provided. Then the points were summed up for each area and the mean score calculated to indicate the relative priority of each area. The rank order together with the mean scores for each area are shown in Table 19. The range for the mean scores of the areas of improvement of

Table 18

The Percentage of Teachers Assessing the Teaching Strategies as strongly recommend or just recommend

	Teaching Strategies	n	Assessment
1.	Students are shown how to solve a problem and then similar practice problems are assigned.	16	93.8
2.	Daily homework assignment are included.	16	87.5
3.	Most lessons are designed to provide opportunities for student discussions.	16	87.5
4.	Activities are included which require group work.	16	75.0
5.	Many new mathematical topics are introduced with a problem to be solved.	16	68.8
6.	Basic ideas are introduced through investigations or experiments with materials.	16	62.5
7.	More than fifty percent of instructional time is devoted to drill and practice.	16	56.3
8.	More than fifty percent of instructional time is devoted to student use of individual study materials to develop and extend ideas.	16	50.0
9.	Students are to read about mathematical ideas before classroom activities are devoted to these ideas.	16	50.0
10.	Most lessons are designed to be conducted with a single large group.	16	50.0

n* This column indicates the number of teachers who assessed each teaching strategy

Table 19

The Rank Order for the Priority of Areas of Improving Secondary Mathematics Education

	Area	Mean Score	Rank
1.	Improvement of preservice and inservice teacher education.	1.235	(1)
2.	Improvement of methods and techniques for teaching mathematics.	1.353	(2)
3.	Development of special materials for students with special needs.	1.647	(3)
4.	Improvement of school conditions.	1.765	(4)
5.	Improvement of mathematics textbooks.	1.941	(5)
6.	Development of materials other than textbooks.	1.941	(5)
7.	Revision of the syllabus.	2.176	(7)
8.	Increase of secondary school enrolment.	2.471	(8)

secondary school mathematics in Tanzania was between 1.235 and 2.471, indicating that teachers assigned the highest to middle level priority to the areas. The highest rated areas in descending order of their priority are, "improvement of preservice and inservice teacher education" and "improvement of methods and techniques for teaching mathematics". The second highest in descending order of priority are, "development of special materials for students with special needs", "improvement of school conditions", "improvement of mathematics textbooks and development of materials other than textbooks". The lowest rated in descending order of priority are, "revision of the syllabus" and "increase of secondary school enrolment".

The teachers were then asked to list three areas which need immediate attention. The areas mentioned together with their frequencies are in Table 20. Three areas with the highest frequencies (in order of their frequencies) are

1. Development of materials other than textbooks
2. Improvement of preservice and inservice teacher education
3. Improvement of mathematic textbooks.

Key Points

1. The highest rated reasons for teaching mathematics are mostly technical, for example, "to develop skills for further studies" and "to solve problems in everyday life".
2. The least rated reasons for teaching mathematics are those which take into account the historical development of mathematics (cultural). These are, for example, "to provide insights into mathematics as Man's abstracting of nature" and "to provide insights into mathematics as expression of Man's intellect and Man's historical development".
3. The least rated classroom orientations are those which

Table 20

The Frequencies of Teachers Assessing the Areas of Improving Secondary Mathematics Education as Requiring Immediate Attention

	Area	Frequency
1.	Development of materials other than textbooks.	7
2.	Improvement of preservice and inservice teacher education.	6
3.	Improvement of mathematics textbooks.	5
4.	Incentives to mathematics teachers.	4
5.	Improvement of methods and techniques for teaching mathematics.	3
6.	Improvement of school conditions.	3
7.	Development of special materials for students with special needs.	1
8.	Students' motivation.	1

call for students developing problem solving skills. For example, "for the teacher and students to spend class time dealing with end of chapter word problems"and "for the teacher and students to spend class time dealing with non-routine, hard problems".

4. The highest rated statement about resources is that which encourage drill and practice. For example, "students workbooks should be included for drill and practice at the conclusion of each lesson".
5. The highest rated teaching strategy is "students are shown how to solve a problem and then similar practice problems are assigned".
6. Areas of improving secondary school mathematics education which need immediate attention are
   - (i) Improvement of preservice and inservice teacher education.
   - (ii) Improvement of methods and techniques for teaching mathematics.

Discussion

An examination of the key points and the findings discussed above suggest the following points. Teachers' views about the reasons for teaching mathematics suggest their perceptions about the nature of school mathematics. Most of the reasons for teaching mathematics which teachers indicated should receive much more emphasis are of a technical type. Also, most of the reasons for teaching mathematics which teachers rated low in emphasis are those which recognize the cultural and historical development of mathematics. It seems that most of the teachers regard mathematics as a fixed body of truth and not as a human activity. A close look at the reasons for teaching mathematics which teachers think should receive emphasis and the classroom orientations which teachers strongly recommend suggest the following. While teachers indicate "to solve problems in everyday life" as the most important reason for teaching mathematics, classroom orientations which call for students developing problem solving skill are rated low. For example, "for the teacher and students to spend class time dealing with non-routine, hard problems" is the least rated classroom orientation. The highest rated classroom orientation is "for the teacher and students to spend class time on explanations and proofs that would reinforce accurate thinking". These findings suggest that teachers do not consider problem solving as an approach to teaching mathematics but as an automatic skill gained from learning the content (pure) of mathematics.

Teachers' views about teaching resources and teaching strategies suggest their perceptions about teaching and learning mathematics. For example, the highest rated statements about teaching resources are "students worksheets or workbooks should be included for drill and practice at the conclusion of each lesson" and tests, homework and specific objectives should be included to encourage each student to attain specified competency level". It seems teachers perceive learning mathematics as drill and practice. The highest rated teaching strategy is "students are shown how to solve a problem and then similar practice problems are assigned". This supports the previous findings about teaching methods. It seem that teachers prefer the transmission-authoritative type of teaching methods.

The teachers views : An overview and analysis

The teachers' views about the importance, interest in teaching and difficulty of the topics listed in the syllabus to provide an understanding of teachers' perceptions of that which constitutes the secondary mathematics curriculum. Concerning the content of secondary mathematics, the findings indicate that teachers perceive the content as the topics listed in the syllabus. Furthermore, the teachers' views about the relative importance, difficulty and "interest in teaching" of the topics indicate the perceptions of the teachers' about the nature of secondary school mathematics. As discussed earlier in this chapter, findings from the questionnaire indicate that teachers assign the least importance to the topics which have a direct application. These topics include approximation and accuracy, variation, plan and elevation and functions. Moreover, there is an indication that topics of geometric nature like congruence and enlargement for form two, circles and spheres for form three are also considered not very important. One possible explanation of these findings is that teachers perceive secondary school mathematics as a body of theoretical factual knowledge with no practical application and, more specifically, as a body of established knowledge and procedures - facts and rules.

Concerning the teaching methods, the findings indicate that teachers perceive the "transmission-authoritative" type of methods as being dominant. The literature indicates that a large number of teachers teach this way in developing countries (D'Ambrosio, 1985, Mbilinyi,1979). The most common methods indicated from the findings are teacher boardwork, having students practice problems independently, and class discussion (teacher/students dialogue). These findings, together with the above mentioned, provide an insight on how mathematics is taught in secondary schools. One explanation can be that provided by Dofler and Mclone (1986):

> More often than not teaching goes in the following way: an exemplary exercise is presented by the teacher to the pupils and the way of solution is presented by the teacher to the pupils and the way of solution is discussed or even formulated as an explicit rule; then follows a long list of similar exercises to be accomplished by the pupils at school or home. These exercises are mostly of a routine character which aim to mechanise the presented path of calculations.

So what we see from the above kind of teaching is that topics that have direct application or those of geometric nature taught in this way are bound to appear very difficult for the students, as indicated in from the findings.

A close look on the findings and the teachers' views about the factors affecting teachers in planning their lessons seem to provide some explanations of the patterns of teaching explained above. First, the findings suggest that examinations influence teachers in prioritizing their lesson objectives. Examinations can have a marked effect on the teachers' approach to teaching.

Secondly, lack of inservice courses on the part of the Ministry of Education or the Institute of Curriculum Development as means of implementing curriculum reform indicated in the findings can have effects on the teachers' approach in implementing the curriculum. One effect can be what Beeby (1966, quoted in D'Ambrosio, 1985) suggests:

> no change in practice, no change in the curriculum has any meaning unless the teacher understands it and accepts it... If he does not understand the new method, or if he refuses to accept it other than superficially, instructions are of no avail. At the best he will go on doing in effect what he has always done, and at the worst he will produce some travesty of modern teaching.

This observation seems to be supported by the teachers' views about the factors influencing the planning of their lessons. The findings indicate that teachers are affected most by their classroom experiences as the most influential factor is "approaches which have worked well in the past". Another effect which can happen because of lack of inservice courses is the reliance on textbooks by teachers in their teaching. In this case textbooks define the curriculum and the methods of teaching. The findings from the questionnaire indicate textbooks as a factor influencing teachers in prioritizing their lesson objectives. The textbooks which teachers use were analyzed in chapter 4.

The books favour the method of teaching described earlier in this section.

Teachers' views of the problems which affect teachers of mathematics provide another explanation for the patterns of teaching described above. Findings indicate the problems of lack of teaching resource, students' background, language (English as a second language to students), and overcrowdedness as being very serious. As noted earlier, problems of this kind can encourage teachers to adopt a survival orientation to their work and incline them towards more control-centred transmission style patterns of teaching. As Hargreaves, (1989) notes:

> Teachers, that is, do not just decide to deploy particular skills because of the recognised professional worth and value, or because of their own confidence and their competence in operating them. Rather they make judgements about the fit between particular skills and the constraints, demands and opportunities of the material environment of the classroom; about the appropriateness of particular styles or techniques for present circumstances.

Another kind of explanation which the findings seem to provide relates to the beliefs of teachers about the nature of mathematics, mathematics learning and teaching. According to Beeby, (1966),

> I am sure that for three quarters of the teachers of the world it (curriculum reform) means a revolution in their teaching practice; for many, it will involve a change in their ideas of the very purpose of education.

Teachers' view about the recommendations for future secondary mathematics program indicate some dominant views of mathematics, mathematics learning and teaching. For example, teachers still believe that a teaching strategy where students are shown how to solve a problem and the similar practice problems are assigned as the best. Although findings indicate that teachers recommend a number of innovative classroom orientations, it is likely that these will remain on paper unless their views are challenged.

CHAPTER 6

THE SECONDARY MATHEMATICS PROGRAM

Introduction

The purpose of this chapter is first to examine and show the changes of patterns and philosophies of secondary mathematics education in Tanzania since independence. Secondly, it is to point out the actualities of the secondary mathematics program. The chapter is presented in three sections. In the first section the aims of secondary mathematics education are discussed. Section two discusses the nature of secondary school mathematics. The teaching of secondary school mathematics is discussed in section three.

Aims of Mathematics Education

An important feature of education is that it is an intentional activity (Oakshott, 1967; Hirst and Peters, 1970, quoted in Ernest, 1991). The intentions underpinning this activity, stated in terms of their intended purposes and outcomes, constitute the aims of education (Ernest, 1991). However, just as Ernest points out, intentions do not exist in the abstract and to assume that they do leads to false objectification of aims. Any elucidation of aims needs to specify ownership, for aims in education represent the intentions of individuals or group of persons. What the above discussion implies is that, in order to discuss the aims of education, we need to consider the social context in order to establish the ownership of the aims.

The aims of mathematics education are the intentions which underlie it and the institution through which it is effected. They represent one component of the general aims of education, combining with others to give the overall aims. Consequently, the aims of mathematics education must be consistent with the general aims of education.

In his study, Cooper (1985) demonstrates historically the existence of different interest groups concerned with mathematics education. These groups have varying aims for mathematics education, and the outcome of the struggle for ascendancy between them indicates their relative power. Just like Cooper demonstrates, the aims of mathematics education in Tanzania at present are the result of struggle for ascendancy between different groups with varying aims of mathematics education. In what follows, I therefore attempt to discuss the above view by focusing on the historical setting of the education system and mathematics education since independence in Tanzania, together with the findings from the teachers' questionnaire.

After independence in 1961, the Tanzania government instituted a few changes to the inherited colonial (British) education system. Among these changes were the abolishment of racial discrimination and the increase of school enrolments at all levels, especially secondary schools. The major intent of the state was to have the school system produce enough manpower to run the new Nationalist state and Party institutions. Thus many of the changes or reforms made at that point of time were just a reorganization of the system rather than a total structural change of the educational base and structure. The education hierarchy remained as it had been under the colonial state.

With the above intent of education, the aims of mathematics education in the newly independent Tanzania remained the same as those inherited from the British system as Damerow (1984, quoted by Bienvenido, 1986) suggests,

> I think first we have to consider the fact that mathematical education in the traditional sense has its origin in a specific Western European cultural tradition, where the canonical curriculum of traditional school mathematics was created

> in the course of the 19th century. The transfer of this curriculum to developing countries in most cases has been closely linked with the institutionalization of schools by colonial administrations in these countries. It is well known that these schools were attended only by an elite, which adopted the Western European culture and often studied afterwards at European universities. Under these conditions it seemed natural simply to copy the curriculum of higher education.

Thus it seemed natural for the Tanzanian government to adopt the aims of mathematics education at that time which were basically the mastery of basic skills for the masses in preparation for a life of work and mastery of a more extended range of mathematics knowledge for the higher levels in preparation for leadership and higher paid jobs. So the major intent of secondary mathematics education was the mastery of a more extended range of mathematics knowledge in preparation for leadership, higher paid jobs and higher education. It was on these grounds also that, the New Mathematics programs became accepted in Tanzania in the early 1960s.

Within several years of independence, the above aims of education began to be questioned by many African countries, Tanzania being one of them. Leaders began to realize that the education system which developed according to the colonial education system contributed to class divisions of a westernized elite, a growing lower middle class, urban workers and the traditional sector. The aspirations for progress and equality led to new questions about the role of the school system in society.

In response to the above, President Nyerere of Tanzania produced the document Education for Self Reliance, which spelled out the framework for education policy in Tanzania after the Arusha declaration of socialism and self-reliance policies in 1967. The proposals set out in Education for Self Reliance were distinguished from current educational characteristics which Nyerere expressed as inappropriate for Tanzanian society. He outlined these characteristics as:

1. Elitism: the education system has been designed to meet the needs and interests of a small proportion of those who enter the school system.
2. The school separation from society: school had been seen as a way up and out of the village and from agricultural work. Thus he noted that "Educated people were alienated from the life of the masses because of the separation and status conferred upon them".
3. The high status of school book knowledge: areas of knowledge from old people and traditional farmers may be valuable and should be respected.
4. The waste of valuable sector of labour: the vast majority of pupils do not think of their knowledge or their strength as being related to the needs of the village. (Saunders, 1982).

To alter these characteristics, Nyerere proposed the following aims of education as can be seen in the following:

> ...to prepare people for their responsibilities as free workers and citizens in a free and democratic society, albeit a largely rural society. They have to be able to think for themselves, to make judgements on all the issues affecting them; they should be able to interpret the decisions made through the democratic institutions of our society...The education provided must therefore encourage the development in each citizen of ...an enquiring mind, an ability to learn from what others do. (Nyerere, 1968).

In order to realize the above aims of education, a substantial number of policy initiatives were taken. Among the changes which were made at secondary level were the curriculum changes designed to influence value and orientations through, for example, changing course content, introducing new subjects and changing evaluation procedures.

As noted earlier in this study, the changes in the secondary mathematics curriculum which led to the National

Secondary Mathematics Syllabus of 1976 were the response to the education for self-reliance education policy. The goals of secondary mathematics, as defined by the curriculum developers of the 1976 curriculum, which were to reflect the general goals of education as given in '<u>Education for Self Reliance</u>' were those stated in the syllabus:

1. To develop mathematics skills among pupils which will enable them to function in all practical affairs of life.
2. To provide pupils with a mathematical tool which they can apply in other subjects.
3. To develop pupils' abilities to discover mathematical concepts and ideas and also their ability to think logically.
4. To prepare pupils for higher studies

A close look at the aims stated above shows the discrepancy between them and the aims of education as stated in the Education for Self Reliance document. In discussing the aims of mathematics education for rural development, Broomes (1981) identified four types of the aims:

1. Social goals which are needed for:
   * working with others;
   * thinking with others;
   * feeling with others;
   * living with and among others.
2. Technical goals which are needed for:
   * mathematics for understanding and studying other subjects;
   * mathematics for the further study of mathematics;
   * mathematics as method of investigation;
   * mathematics for the working roles we have to play.
3. Cultural goals which are intended to provide insights into:
   * mathematics as a symbolic system;
   * mathematics as expression of Man's intellect and of

Man's historical development;
* mathematics as Man's disentangling of Nature;
* mathematics as a way of thinking and communicating thought.

4. Personal-Aesthetic goals, which are of two broad types:
   * the personal types, which stimulate curiosity and intellectual excitement, and those which permit personal expression;
   * the aesthetic types, which aim to convey an appreciation of mathematics as a deductive system and of mathematics as concerned with patterns and shapes and order.

Upon looking on the aims of education as stated in ESR, it can be argued that, for aims of mathematics education to reflect them, all of the above types should be included. All except one of the aims stated in the syllabus of 1976 fall under the technical type. Thus, in general the aims of mathematics education as defined by the curriculum developers of the 1976 syllabus did not reflect the aims of "Education for Self Reliance'.

It was discussed in chapter four that the syllabus and curriculum materials developed in 1976 reflected ideas and concepts of the New Mathematics programs adapted from Europe and USA. Hanna (1983) summarized the factors which led to the reforms which resulted in New mathematics curriculum as:

1. The extraordinary growth of mathematics and its tendency to increased abstraction.
2. The increasing dependence of other scientific disciplines upon mathematics.
3. The emergence of set theory as a unifying concept, primarily through the work of Bourbaki.
4. The introduction of the new courses at the university level, more abstract in subject and more rigorous in presentation.
5. The lag of the secondary school curriculum behind that

of the universities, and dissatisfaction of mathematics professors with the level of preparation in mathematics of incoming students.

6. The desire on the part of practising mathematicians to infuse the secondary school curriculum with the excitement of the new developments.
7. The growing awareness on the part of the high schools themselves that their curriculum was outmoded.

Thus, while the aims of secondary mathematics education as stated by the curriculum developers were mainly technical the aims implicit in the curriculum materials were those concerned with the development of mathematics as a discipline itself, that is to transmit pure mathematics knowledge with an emphasis on the structure, conceptual level and rigour of the subject.

As noted before in this study, the structure of the Tanzanian education system is, like in other developing countries, pyramidal. This means that only a small percentage of students completing primary education secure places in O'level secondary schools, and only a few of these join A'level. For example, with the rapid rise of primary education after the Arusha Declaration, only 3.1% of primary leavers managed to secure places in secondary schools between 1977 and 1984 (Cooksey, 1986). Because of the nature of the education system, examinations play a greater role in the selection of the few students who enter secondary schools and higher education. Despite the efforts to reform evaluation procedures in Tanzania by introducing character and work attitudes assessments in examination results, the examinations still assess on academic grounds. For example:

> A mere 0.1 percent of the students who sat for the examination in 1976 qualified in the academic section but failed to receive a certificate because of their low character assessment. (Court and Kinyanjui, 1978 quoted in Cooksey, 1986).

Also,

> Although 5% of all candidates were automatically disqualified from form five through poor character assessment, almost all of them were poor or modest achievers who would have failed on academic grounds alone (Court and Kinyanjui, 1978).

Because of the aims of New Mathematics and the nature of education and examination systems in Tanzania, the 1976 curriculum materials were accepted by teachers and students in secondary schools with the aim of preparing the few students who would enter university. Secondary education was regarded as a transition stage. Modern mathematics continued in Tanzania until 1989 when the new curriculum was introduced for form one. So mathematics appeared to be accepted by students as difficult and irrelevant for other reasons except for obtaining a passport to further studies.

The above attitudes have grave consequences for secondary mathematics education in Tanzania. Teachers teach for examinations. This attitude was also indicated in the questionnaire administered to teachers in this study. Most of the teachers indicated that examinations influence mathematics teachers in prioritizing their lesson objectives. Teachers also indicated that students find most of the topics listed in the syllabus difficult. Teachers indicated that many students fail the National Form Four Mathematics examination. When asked to comment on this, many teachers who responded to this blamed the students for not showing interest, not being serious and not working hard. This is not surprising because secondary education for many students is regarded as being a transition stage to university, and since only few of them will join the university, however difficult mathematics may appear, it is accepted by many students with resignation.

As we have seen from the above, the aims of modern mathematics in Tanzania had negative outcomes on education in Tanzania. From the teachers' point of view, modern mathematics demand mastery of intensive mathematics content. This means therefore that the attitude of average medium-level teachers towards modern mathematics is ambiguous. On the one hand, they probably realize that they have not been adequately trained and that the academic level of their classes needs to be improved. On the other hand, however, they themselves have not mastered the new content or the new formal methodology of mathematics and thus are not motivated to implement the changes required of them.

From the students' point of view, modern mathematics, as we have seen, demand at an early stage a degree of conceptualization of which the average student was incapable. At the same time, formalization reduces the emphasis on the application of mathematics, and hence the pupil's motivation to understand and master it. This problem, together with that of teachers, results in the failure of many students in examinations. Thus, the society became aware of elitism inherent in the over-formalized teaching of mathematics, which was originally condemned in ESR.

A close look at the aims stated by the curriculum developers and those implicit in the curriculum materials of 1988, shows that neither the factors mentioned above nor the changes ESR proposed have had impact on the renewal of the mathematics curriculum. Although the curriculum developers disregarded the aim of teaching mathematics for further studies, teachers still, as indicated by the questionnaire responses, teach students so that they pass examinations. Furthermore, the substitution for formalization in modern mathematics by rules, definitions and facts in the curriculum materials makes matters even worse. This is because the students, even the few who could manage the formalized approach, are encouraged to memorize facts so as to recall them in examinations.

School Mathematics

Perhaps one of the most discussed issues in education in the continent of Africa is the question of the relevance of education for development (Eshiwani, 1979). Many speakers in different forums at local and international levels have called for public education which is relevant to the African needs of today and tomorrow in content, approach and values. Because of this demand for localization of education in Africa, mathematics curriculum programs, adapted from Europe and the USA, have come under attack because they seem to have served the needs of a small percentage of the school population and tend to ignore the needs of the great percentage of the population, which is comprised of school leavers who will not make it to the higher reaches of the education ladder. Although the mathematics curricula above have been attacked on the grounds that they were carbon copies of various curriculum packages in the West, very little has been done to question what school mathematics content will actually reflect the African needs and values. Most of the changes made in the curricula have been only to the flavour rather than to the entire content, as Lillis (1985) observes:

> It is thus difficult to know what an African mathematics program is - other than an international series of symbols, axioms, philosophy and language with an African flavour.

If we turn to the situation in Tanzania, we find the same trend as far as the changes made in the content of school mathematics is concerned. As we have noted earlier, just after independence the new nationalist government was committed to extending educational opportunities to its people. Therefore, no significant changes were made to the content of mathematics curriculum in Tanzania at that time. The content of mathematics remained the same as that inherited from the British, with arithmetic and mensuration being confined to primary schools and a more extended range of mathematics knowledge in preparation for university entry. School mathematics continued to be conceptualized as a single discipline, free from cross curricular links and social values (Lawlor, 1988, quoted in Ernest, 1991).

I have already suggested that it was not long after independence that Modern or New Mathematics was introduced in Tanzania through SMEA (adapted from SMP) and Entebbe Mathematics (adapted from SMSG) projects. I also noted earlier that the impetus to changes that led to the New Mathematics project came from university academicians. It should be noted that, although the SMP project was the work of educationalists, these educationalists mainly represented the elitist public and grammar schools. Because of the nature of the education system before independence, very few Tanzanians had received higher education. With the lack of a developed education infrastructure, coupled with the paucity of educational research on the African context and the absence of personnel to provide alternative curricular definitions, it is understandable that Tanzania would look to the Western world for its modern mathematics curriculums. Moreover, the transfer of curriculum from developed countries to developing countries at that time was considered to be unproblematic because of the dominance in epistemology and educational philosophy of the positivistic school characterised by the work of Hirst in the UK and Phenix in the USA (Lillis, 1987). According to this school, the central position in the curriculum is knowledge per se and not the knower. Knowledge is seen as a reflection of an objective reality of the physical world and possessing an inherent objective rational structure. Therefore, mathematics as a form of knowledge is characterised by a distinctive set of concepts, logical structure and methods of inquiry. These are characteristics of the form itself, and as such, are universal rather than specific to particular social organization. It is this universal nature which is important to teach.

The content of school mathematics, as reflected in the syllabuses and textbooks of SMP and Entebbe projects, was discussed in chapter four. The nature of the content bears strong beliefs in the mathematics discipline as the only source of content - "the disciplined knowledge". Therefore, despite the efforts to adapt the curricula to local needs, modern school mathematics in Tanzania remained the same as that of Western countries.

Earlier in this chapter we saw how the aims of '*Education for Self Reliance*' challenged the education system inherited from the colonial state. We also saw that, among other changes which '*Education for Self Reliance*' demanded, was change to the curriculum itself. '*Education for Self Reliance*' demanded such change as Nyerere notes:

> Instructional content tends to be irrelevant because it still reflects undesirable characteristics of the colonial past which intended to inculcate the values of the colonial state. (Nyerere, 1968)

In discussing what Nyerere believed about the nature of knowledge in ESR, Okoh (1980) observed that:

> Nyerere believed that all knowledge had its origin in human experience, especially in human needs. For this reason, knowledge could not be separated from the concrete problems of experience which require solutions. Nyerere's events oriented philosophical style made it impossible for him to think of knowledge except in terms of some positive action. Nyerere insisted that the Tanzanian school system must provide the type of knowledge which would enable the pupil to acquire the values of the society he lived in while contributing to its material welfare.

As I suggested earlier, a number of policy initiatives were taken in order to implement ESR objectives. The part of the policy which signalled a significant departure from conventional schooling suggested a redefinition of the relationship between the dominant literate medium of education and practices associated with practical action. As a result of this, productive projects were included in the secondary curriculum. A secondary school was to be considered at the same time as a farm or a workshop. And the relationship between the school farm and other aspects of school life was to be, as Nyerere (1974) refers the following:

> The farm work and products should be integrated into the life, thus the properties of fertilizers can be explained in the science classes, and their use and limitations experienced by the pupils as they see them in use. The possibility of proper grazing practices and of terracing and soil conservation methods can all be taught theoretically at the same time as they are put into practice.

How far has the challenge of ESR been tackled in the development of a mathematics syllabus for secondary education since 1967? The content of the National Syllabus of 1976 was discussed in chapter 4. There it was noted that the syllabus was a reflection of the New Mathematics projects (SMP and Entebbe) in content and approach. Thus, like these projects, the content of school mathematics was derived according to the assumptions of the old humanist ideology (Ernest, 1991). According to this ideology, the source of curriculum content is from pure mathematics per se, with emphasis on the structure, conceptual level and rigour of the subject. It seems that the curriculum developers of the 1976 syllabus perceived the mathematics curriculum for self reliance as that in which materials development is rationalized in local terms, decision making is localized and the context of materials has a local flavour (Lillis, 1985). The fundamental question as to what really is the nature of mathematics knowledge, as suggested by ESR, was not addressed. Certainly socialist attitudes were not going to be developed by changes of names, as

Baghat (1970), quoted in Woodhouse (1971) notes:

> We must stress that socialism is not developed by word changes. Replacing 'Plymouth' and 'London' with 'Tanga' and 'Dar-es-Salaam' does not make the mathematics any more socialist.

As noted earlier, modern mathematics continued to be taught in Tanzania until the new syllabus was planned in 1988. In fact, the productive activities suggested in ESR came to be regarded as activities separate from classroom practices or extra-curricular activities (Saunders, 1982).

The content of the revised syllabus of 1988 was analyzed in chapter four. A close look at the analysis shows that the same pattern has persisted with regard to the selection of the content of mathematics education for secondary schools. The fact that the topics listed in the new syllabus remained the same as those in the 1976 syllabus suggests that the curriculum developers were less concerned with the nature of school mathematics knowledge and more with the means by which it can be communicated to the students. It seems that the major problem for the developers was to find efficient means by which teachers could teach to achieve specified outcomes. Therefore, the new syllabus included specific objectives for each form, topics and subtopics. The topics were arranged in logical sequence to ensure smooth learning. Implicit in this view is the assumption that learning occurs in systematic and predictable ways. Also, as discussed earlier, the content bears belief that mathematics is a clear body of knowledge and a set of techniques to be memorised and practised.

The above assumptions underlying the revised mathematics curriculum of 1988 have serious consequences to mathematics education in Tanzania. Unlike the modern mathematics curriculum which acknowledges mathematics as a rational discipline with its internal structure and logic, the curriculum ignores the rational theoretical basis of mathematics by presenting school mathematics as merely facts and techniques (Ernest, 1991). Thus, mathematics appears to have no meaning and relevance to the students' point of view. Learning is reduced to the level of memorising and the reproduction of pure facts.

The above observations appear to be supported by the findings from the questionnaire. Although in general, these findings suggest that teachers consider most of the topics listed in the syllabus important for the students, they also suggest that students find most of the topics fairly difficult. Also, many topics which require thinking skills like problem solving, estimations, spatial reasoning and logical reasoning are considered relatively less important for the students. In most cases these are topics which students find difficult. Teachers also find them not interesting to teach. Examples of these topics are approximation and accuracy, variation for form one, enlargement, vectors, congruence, similarity for form two, plan and elevation, circles, spheres for form three, and three-dimensional geometry and probability for form four.

The teaching of secondary school mathematics

Since the time of independence, the Tanzanian nationalist government continues to have control over the education system in what is known as the 'Centralized System of Education'. The activities of education has been left in the hands of the Ministry of Education. The Ministry of Education controls all matters related to education, including administration, curriculum and examinations. However, to make easier the development of curriculum and examinations, the Ministry of Education, through the parliament, created two separate parastatal vested with these two tasks. That is, the Institute of Curriculum Development (originally known as Institute of Education) is vested with the task of curriculum development for the primary, secondary and teacher training colleges; and the National Examination Council is vested with the task of developing examinations in such areas as setting and of examinations for the above-mentioned levels of schooling, as well as issuing of examination certificates for those who pass their examination. Thus, although the curriculum is developed by the Institute of Curriculum Development, decisions on what should be the final and accepted version of the curriculum, the methods of teaching and what school textbooks should include as the content have to pass through the 'rubber stamp' of the Ministry of Education bureaucratic officials.

In discussing the possible roles of teachers in curriculum implementation, Ben-Peretz and Silberstein identify three different scenarios:

1. Teachers may be treated as transmitters of curricular ideas through "teacher proof" materials; teachers, especially inexperienced teachers, may view any set of materials as "teacher proof", and may feel limited in their freedom to consider change, and may doubt the legitimacy of adaptation.
2. Another view recognizes the considerable influence teachers have on the implementation of curricular ideas. This view may lead to the attempt to "convert" teachers to the ideas and practices embodied in curriculum materials by way of workshops and other training activities.
3. A third approach to the role of teachers assumes teachers to be full partners in the process of curriculum developments as "user-developers" (Connelly 1972). Teachers are expected to adapt and mould curriculum materials to their own purposes and to the requirements of their specific educational situations (Ben-Peretz 1975).

The circumstances surrounding the centralized education system described above, suggest that teachers in Tanzania fall under the first or second category, but most likely the first. As Mbilinyi (1980) observes:

> They (teachers) teach curricula which they do not design; and teach for examinations which they do not set. Teachers and their heads carry out directives from above, in a pattern of work relationship not unlike that between teacher and student.

These observations are supported by findings from the teachers' questionnaire. A significant number of teachers were of the opinion that education circulars was the common method by which syllabuses are communicated to teachers. Moreover books used for teaching and learning mathematics are those issued by the Ministry of Education. The alienation of teachers from their superiors (Ministry of Education officials) creates an atmosphere of insecurity among many teachers in that they dare not question the content of the materials and thus rely on the textbooks and syllabuses in their teaching of mathematics. Furthermore, the lack of inservice courses on the part of the Ministry of Education or the Institute of Curriculum Development as a means of implementing curriculum reform make teachers rely on the approaches that have worked for them before, as the findings indicate.

Earlier in this chapter, I discussed how examinations affect the teaching of mathematics in secondary schools. Howson and Mellin-Olsen (1986) suggest that classroom activities which are likely to get on with an examination centred class are exposition by the teachers, consolidation and practice of fundamental skills and routines, and an impoverished form of problem solving, including the application of mathematics to everyday situations. The findings from the teachers' questionnaire tend to agree with this observation. Methods of teaching which were rated highly as "frequently used" were teacher boardwork, having students practice problems independently and teacher/class discussion. It is likely that this situation, together with reliance of teachers on textbooks in teaching mathematics, results in rote teaching and learning. Thus, many students fail the examination, as we have seen, and appear to be unmotivated and not serious in their learning of mathematics, as suggested by the teachers in the findings. Other methods of teaching which were likely to motivate learning, like student-directed class discussion, inquiry-based activities, small group activities and teacher demonstration were rated by the majority of teachers as "never used".

CHAPTER 7

RETHINKING SECONDARY MATHEMATICS EDUCATION

Introduction

The analysis of the secondary mathematics program discussed in this study, reveals several aspects of the dynamics of curriculum change that enhance our understanding of the change process in Tanzanian secondary mathematics education. Some of the issues raised in this study which are most relevant to future undertakings are discussed below.

Several consequences of the change process were traced to adaptation concentrated on content modification on the part of curriculum developers without questioning very deeply aims, dominant views of the subject-based nature of academic knowledge, and pedagogy. This generated a dichotomy between, for example, what is intended and what is interpreted by the teachers. In fact the major issue in this study is that curriculum change does not occur independently of a change in beliefs about the nature of mathematics, the nature of mathematics learning and the nature of mathematics teaching of all people involved in the curriculum change, especially teachers. Steiner (1987) observes:

> Concepts for teaching and learning of mathematics - more specifically: goals and objectives (taxonomies), syllabi, textbooks, curricula, teaching methodologies, didactical principles, learning theories, mathematics education research designs (models paradigms, theories, etc), but likewise teachers' conceptions of mathematics and mathematics teaching as well as students' perceptions of mathematics carry with them or even rest upon (often in an implicit way) particular philosophical and epistemological views of mathematics.

In what follows I discuss some of the issues which have emerged from previous chapters by focusing on the issues mentioned above. These are teachers' perspective, aims and actions of mathematics education, program development process, the secondary school mathematics curriculum, and the teaching of secondary school mathematics. Each section, with the exception of the first, is presented in two parts. The first section provides the reader with an outline of the issue discussed. The second section presents some recommendations.

The teachers' perspective

In this section the underlying assumptions of the teaching practices implied from the findings of the questionnaire are discussed, alternative assumptions are suggested.

Most difficulties in mathematics teaching hinge on the perception by teachers of the nature of mathematics. Whether teachers implement the objectives of teaching mathematics in secondary schools identified in the syllabus depends on how the intended curriculum is filtered through the teachers' beliefs and conceptions of mathematics. Most teachers' perceptions of mathematics are shaped by the way they were taught the subject at school. However, because of the unquestioned inclusion of mathematics in the school curriculum, most teachers do not see the need to justify its place and purpose to the students and therefore have never felt the need to examine and challenge their own beliefs about the nature of mathematics.

The findings from the questionnaire indicate dominant beliefs which centre around the teachers' perceptions of the nature of mathematics, nature of learning and teaching of mathematics. For instance, most of the teachers identified the primary reasons for teaching mathematics in secondary school as being "to develop skills for further studies", "to think logically" and "to solve problems in everyday life". The view that the study of mathematics leads to logical thinking seems to have the following implications for teachers' beliefs about the nature of mathematics. Mathematics is seen as a static discipline based on organised and logical symbols and procedures. Mathematics is seen as accurate, precise and logical. It is seen as consistent, certain and free of contradictions and ambiguities. The view that mathematics should be taught so as to develop skills for further studies implies that one should learn mathematics so that one can take more mathematics. This assumes both the logical and hierarchical nature of mathematics. The belief underlying this assumption is that mathematics must be taught in a logical order. If students do not know how to do the basics they cannot progress further.

Because of the above beliefs, most teachers seem to have a very restricted view of the content of school mathematics. That is, the topics in the syllabus and more strictly the examination syllabus are arranged in a logical order purportedly to facilitate learning. Mathematics seems to be understood as a body of established knowledge and procedures, facts and rules, as depicted in the forms in which mathematics is observed in calculations, proofs and standard methods. In fact, the view that mathematics should be studied in order to solve problems in everyday life seems to mean the study of these mathematical procedures, rules and definitions and the application of them to problems in everyday life. If we agree that the mathematics curriculum should reflect the discipline of mathematics, then it must not represent mathematics as having a fixed hierarchical structure, as most mathematicians would see this as a narrow view of their subject. It denies the value of mathematics as an activity in which to engage. Decision making, experimenting, hypothesising, generalizing, modelling, communicating, interpreting, and pattern finding are crucial parts of that activity. Therefore, such reasons for teaching mathematics as "to provide insights into mathematics as Man's abstracting of nature", "to provide insights into mathematics as expression of Man's intellect and of Man's historical development" and "to convey an appreciation of mathematics as concerned with patterns", shapes and order (included in the questionnaire) should receive more emphasis.

The teachers' views about the nature of mathematics influence what they perceive as the nature of mathematics learning. The restricted view of the content of school mathematics as the examination syllabus and the view that mathematics is a body of established knowledge and procedures, facts and rules have consequences for the learning of mathematics. Generally, learning seems to be interchanged with remembering. The findings from the questionnaire indicate that, in most mathematics lessons, students are taught the rules, technical notations and established conventions of mathematics without acquiring any feeling for why these systems exist. Relying on a set of rules taught by the teacher is only as good as the student's memory allows for instant recall. Because of this, it is assumed that students need clear, step-by-step explanations in order to avoid confusion. Therefore, in order to make things easier for students, the following actions seem to be apparent. First, the subject is broken down into 'easily digestible topics'. This feature is very much apparent in the syllabus and the secondary mathematics books of 1988. For example, the topic of numbers is broken into number and real numbers. The finding that form-one students find real number relatively more difficult than numbers suggest that they do not see the relationships between these topics. Secondly, difficulties are smoothed out for students. Again the secondary mathematics books support this practice. The mathematics presented in these books appears to be well structured and logical but, as I have discussed earlier in previous chapters, this presents a false view of the subject. Thirdly, it is often assumed that techniques must be learned and practised before problems are mentioned. The indications from the questionnaire that teachers prefer resources in which students' workbooks and worksheets are included for drill and practice at the conclusion of each lesson and teaching strategies in which students are shown how to solve a problem and similar practice problems are assigned support this practice.

The information derived from the questionnaire, however indicate that, although teachers seem to prefer the above practices, many find that this does not enable their students to succeed. They report that their students often are not interested in the subject. They find them not serious. This is because of the teachers' restricted view of the nature of mathematics and mathematics learning. If students' mathematical knowledge is to develop, teachers' views about mathematics and mathematics learning have to be broadened. To present and teach mathematics in the narrow way I have discussed above is to deny students the experience of actually doing mathematics themselves. Mathematics as an activity is effectively learned by engaging in the processes which are integral parts of this activity.

Perception about students' learning has serious implications for the actions taken by teachers in classrooms. For example, the view that students need clear step-by-step explanations in order to avoid confusion seem to imply that good teachers are ones who can pass on their expertise through clear explanations so as to avoid confusing their students. This has the following consequences on what teachers perceive as their role in mathematics classrooms. First, the teacher is perceived to be the holder of answers in a classroom, one who knows the answers to all of the students' questions. Secondly, in a climate of teacher expertise, well-defined methods and careful explanations, teachers often feel obliged to provide tricks in order keep students in focus so as to get through the syllabus. Thirdly, the teacher perceives herself as having total responsibility for leading and controlling the work that is going on in the classroom. The view that the teacher is the holder of answers creates an answer-oriented atmosphere which inhibits further exploration on the part of students. This fosters a lack of independence and a loss of confidence on the part of students. This also helps to perpetuate the view of mathematics where the only problems are those with the right or wrong answer or right or wrong method. In order for students to develop a real appreciation of mathematics, a classroom atmosphere in which students see and discuss more solutions and strategies is favourable. The view that the teacher is obliged to provide clever tricks leads to the teacher precluding the students' own ideas and also takes away the students' enthusiasm and enjoyment of getting through themselves. The view that the teacher has total responsibility for leading and controlling the work that is going on in the classroom leads to a situation where students rarely get the chance to use their own initiative and therefore become dependent on their teacher for direction. Complaints that students do not work hard, and that students are not serious, are likely to arise because of excessive teacher authority.

Perceptions of the nature of the teachers' role in classrooms has a powerful impact on the way teachers select teaching methods. All the above roles are likely to encourage teaching methods which reflect the view of teaching as the transmission of information from the teacher to the students. Thus, students are passive receivers of information. The findings from the teachers' questionnaire indicate that most of the teachers in fact use these teaching methods. For example, the most common methods identified by teachers are teacher boardwork, having students practice problems independently and teacher/class discussion. It is very likely that mathematics lessons are characterised by little opportunity for students to contribute to, or take responsibility for, their own learning to develop self-confidence, independence and similar personal qualities. For this to happen teachers need to challenge their own views about the teachers' roles in classrooms and thus use a variety of teaching methods including student-directed discussions, inquiry-based activities and small group discussion to facilitate the learning of mathematics.

Aims and actions of mathematics education

<u>The situation</u>

We have found from Chapter 6 that very frequently there has been a mismatch between the aims of education and actions taken by teachers, for example, the aims of education as stipulated by ESR and the aims of mathematics education indicated in the syllbuses, and the aims implicit in the syllabuses and the actions taken by the teachers. Three reasons were identified in the review of literature in this study. These were the inadequate levels of teacher training, the teachers' isolation from the design and planning of curriculum change and teacher resistance to change based on established practices and rewards (Husen, 1978). Responsibility for solving the first problem seems to lay with the institutions which train and offer seminars to teachers. As the recommendations of the 1982 Presidential Commission on Education, as approved by the Government and the Party suggest:

> Many teachers in our school system use the lecture or teacher centred approach to teaching. Because

> of this problem, many students fail to understand the concepts and lessons taught. Therefore institutions which train and offer seminars to teachers will put emphasis on the importance of teachers developing and using better teaching methods. Teachers will also be encouraged to develop new and better teaching methods on their own and in the unique situations they find themselves in.

On the matter of the isolation of teachers from curriculum design and planning, the Presidential Commission recommended that the centralized system of curriculum to continue. For example, in discussing the teaching of mathematics, the Commission recommended that the Institute of Curriculum Development continue to revise the Mathematics Syllabus for Primary and Secondary schools. It seems that the Commission thought that the teachers were not qualified to participate in the process of curriculum renewal. While the explanations or solutions of the kind given above have political attractiveness, their underlying assumptions can be called to question. The solutions are based on the technical way of understanding teachers' behaviours in classrooms. With this understanding, when teachers are seen not to display the observer's own preferred skills, they are diagnosed as not being competent in their use. Teachers are seen to display personal qualities of which the observer disapproves, so it is assumed they lack more desirable ones. Thus, when preferred skills and qualities are not observed, it is assumed the teachers concerned simply do not have them and should therefore be supplied with them (training). Clearly, it can be seen that the above explanations or solutions do not address the third problem, namely, the teachers' resistance to change based on established practices and rewards. I would like to argue that, in order to address this problem, we need to ask the question why teachers do what they do and not why teachers do not do what we expect them to do. This is because, as Hargreaves (1989) argues, much of what we call teaching quality (or its absence) actually results from processes of a social nature, from teachers actively interpreting, making sense of, and adjusting to the demands and requirements their conditions of work place upon them. In fact, I would like to argue that, among other reasons, much of the mismatch between the aims of education, the aims of mathematics education as given in the syllabuses and the methods employed by teachers can be explained by the demands placed by the discipline-oriented view and the imposition (top-down) of the National Secondary Mathematics program on the teachers as well as students.

Earlier in the previous chapter I discussed how, despite the intentions of its developers to respond to the aims of ESR whose basis was to unite theory and practice, the National Secondary Mathematics syllabus of 1976 reinforced the discipline-oriented view of curriculum. Thus, for example, the ESR projects which were introduced in the schools to provide an environment for the students to learn from their experiences came to be interpreted by teachers as extra-curricular activities having nothing to do with mathematics. Also, excessive formalization in the syllabus demanded much from the teachers and students. Since most of the students are incapable of dealing with this kind of formalization, they become unmotivated and come to consider themselves as failures. Consequently, many students fail the examinations. This has a great impact on the actions taken by teachers in classrooms. Probably the immediate solution is to resort to the exposition methods of teaching that the findings from the questionnaire seem to suggest. Another factor which helps to reinforce the mismatch between the aims and instructional practice of mathematics education is external examinations. The findings from the questionnaire indicate that this is the most influential determinant of the actions taken by teachers. For many teachers, then, the presence of examinations seems to constrain them in their approach to classroom teaching. It limits innovation and inhibits their willingness to explore new teaching strategies. Achievement-conscious students may conspire with their teachers in this process of limitation too, drawing them back to 'safer' pedagogical ground when exploration threatens to divert them from their examination destination.

Another reason why there has been a mismatch between the aims of mathematics education and the actions teachers take in their classrooms is the way they perceive the nature of mathematics and the learning and teaching of mathematics. The preceding section serves to indicate how teachers' perceptions about the nature of mathematics and the learning and teaching of mathematics can influence the actions teachers take.

Other constraints which account for the mismatch of the aims and the actions teachers take are a lack of resources, the continuation of large classes and a high teacher-student ratio.

Recommendations

1. There is a need to redefine the secondary mathematics program so that it includes a widening of mathematics educational experiences and achievements for all students beyond the predominantly discipline oriented domain, to include ones in the social and personal, aesthetic and practical domains also. The redefinition of the secondary mathematics program is a necessary but not sufficient condition for the matching of aims and actions of mathematics education, for as we have seen, the way teachers perceive the nature of mathematics and the learning and teaching of mathematics has a greater influence on the actions teachers take in the classrooms.
2. Therefore, teachers should be involved in the process of

the evolution and implementation of the aims and their associated actions.

3. As for the other constraints, there is a need to ease and improve those conditions that currently incline teachers towards survival, little more than mere coping, and the associated actions.

4. This implies that policy makers should suggest policies that will lead to a more thoughtful resource allocation to the system to improve the material environment of teaching. The importance of the above kinds of recommendations relates to the process of curriculum development. This is discussed in the following section.

Curriculum development process

The situation

Curriculum development is ultimately about teacher development. Change in the curriculum is not affected without some concomitant change in the teacher (Stenhouse, 1980). What the teacher thinks, what the teacher believes, what the teacher assumes, have powerful implications for the change process, for the way in which curriculum policy is translated into curriculum practice. Earlier in the previous section I discussed how the discipline-oriented nature and the centralized model of curriculum development in Tanzania has helped to reinforce the mismatch of the aims of education and the actions taken by the teachers in their classrooms. I have argued that this will require redefinition of the mathematics curriculum which recognizes and rewards practical, aesthetic, and personal and social achievements for all students. I have also argued that this redefinition of the curriculum is not enough for the change process to be effected unless teachers are involved in the decision process. It goes without saying that in the centralized system of curriculum development this opportunity is unlikely.

The implication of the above discussion is probably that Tanzania should opt for the decentralized model of curriculum development. This will mean handing the responsibily of curriculum development and design to schools, for example. The findings from the questionnaire seem to suggest widely shared patterns of thinking, belief and assumptions among the teachers of mathematics in Tanzania. These amount to what Hargreaves (1989) calls the culture of teaching. In the first section in this chapter I discussed how this culture of teaching can inhibit curriculum change. It is therefore likely that the decentralized model of curriculum development combined with this culture of teaching will allow the discipline oriented curriculum to continue by default. The curriculum debate will be confined to classroom experiences. The secondary mathematics syllabus of 1988 serves as an example of this limitation. The curriculum developers of this syllabus claim to develop the syllabus from teachers concerns. A close look at teachers' views indicated from the questionnaire and the analysis of materials for this syllabus suggests that teachers agree with much of what is in the syllabus. Given what the findings from the questionnaire indicate about teachers' views, it seems obvious that the discipline-oriented nature of the curriculum is maintained.

Recommendations

1. The situation discussed above defines what we may call the central dilemma of curriculum reform and its relation to teaching. On one side of this dilemma is the decentralized model of curriculum development and its limitation to curriculum debate and on the other side is the centralized model of curriculum development and its dependence on teacher development. Clearly there is no clear cut answer to the way of resolving this dilemma. Probably the best

curriculum development model would be that which would somehow utilize the best features of each side. One alternative to this approach will be to allow curriculum development and decision making to be substantially decentralized. It must be given to the teachers and the schools.

2. However there must be a limitation on teacher discretion and independence in curriculum judgement. Therefore, there must be a set of guidelines or standards, centrally produced, directing schools to provide a broad and balanced mathematics curriculum in a way that recognizes and rewards in equal measure a wide range of mathematics educational achievements. One such example is the Curriculum and evaluation and teaching standards (NCTM, 1989). In the following sections I discuss briefly some standards or guidelines for the Tanzanian mathematics curriculum.

The secondary mathematics curriculum

The situation

Earlier in this chapter I discussed the mismatch between the aims of education as stipulated in ESR and the actions taken by teachers in their classrooms. One of the arguments brought forward was that the match between the aims of ESR and the actions taken by teachers would likely be significantly enhanced if the curriculum were developed beyond its present discipline-oriented limits. This is because the discipline oriented curriculum gives disproportionate weighting to academic, intellectual achievement above all others. By offering academic rigour only where there is little social or practical relevance, it makes educational achievement all that more difficult to attain for many students. I have argued that there is need to redefine the curriculum so that it recognises and rewards practical, aesthetic, personal and social achievements. Before I suggest some possibilities for this, I will discuss what has been the situation in the process of redefining the secondary mathematics curriculum since ESR.

Since 1967, the aims of education in Tanzania have been those outlined in the Education for Self Reliance (ESR). In general the intent of formal education in Tanzania has been to develop the potential of individuals, making them better able to contribute to their own well being and to the development of society (Nyerere, 1985). As a result of the ESR policy, a number of initiatives have been taken aimed at furthering one or another of the aims of ESR. Among these initiatives were curriculum changes which would ensure educational equality and opportunity and curriculum content which would be appropriate for problem solving in the rural life in Tanzania.

A close look at the changes which were made in the secondary mathematics curriculum reveals the following problems. As noted earlier, the syllabus which was a response to ESR was that of 1976. I also noted that this was a combination of the New Mathematics programs, the SMP and Entebbe adapted from abroad. The fact that these programs were combined with little or no critical analysis was quite detrimental to the Tanzanian curriculum. It generated a curriculum based on inconsistencies of various kinds.

Since 1967, Tanzania has been attempting to expand educational opportunities to all children. For example, the government started what was called the "quota system" to spread form one entry to all regions. This means that most of the students who joined the secondary schools came from rural areas. As we have seen, the objective of the New Mathematics reformers was to narrow the gap between university mathematics and school mathematics. As a result the New Mathematics curricula were designed in a way that was to build blocks for further mathematics learning. Thus the majority of students who could not go to university ended up acquiring only the first few building blocks of mathematics. And these, considering the nature of the curricula, might not help them in their real situations.

Turning to the question of curriculum content which is appropriate for problem solving, attention should be focused on the two projects which formed the National Syllabus of 1976. This is because the approaches of Entebbe and SMP were different. While Entebbe relied heavily on the early introduction of abstraction, SMP did not. For SMP, ideas were to grow from students' familiar experiences. We have seen from the discussion of the content of Entebbe Mathematics that the relationship between mathematics and its applications was that of an automatic appendage. It was assumed that the study of the logic and underlying structure of mathematics would enable students to solve problems. This approach to problem solving is challenged by McPeck (1981, quoted in Abraham and Bibby, 1988) when he says:

> the requirement for assessing a problem critically are epistemological, not logical in character. It follows that expert manipulation of logical relations within the paradigms of academic mathematics gives no guarantee of, or even cognitive basis for critical thinking.

Thus, although the developers of 1976 syllabus claimed to include practical applications in the syllabus, it was not guaranteed that students would be able to apply their knowledge in their daily lives. The same case applied to the SMP syllabus. As we have seen before, although ideas were to grow from students' familiar experiences, it was the abstraction of concepts from concrete situations and not the other way around which was emphasized. This approach reveals very little about real world applications. This is because the real world is represented as fragments, and fragmented activities within which mathematics concepts hang and can be resurrected as abstract concepts. As noted earlier, the content of the present syllabus is very similar with that of 1976. However, the focus is different. It seems that the developers were concerned with neither the content nor the learners. Their concern was with the means by which the knowledge (content) is communicated to the students. So the focus of rigor and emphasis on the language and structure of mathematics has been diminished. Instead, mathematics is presented as a body of facts and techniques. The findings from the questionnaire and the analysis of the content shows very little evidence of a problem solving approach in the curriculum. For example, the topics which lend themselves directly to practical applications are treated superficially. Therefore, students find them difficult to understand. Moreover, the study of geometry is developed through definitions and formulas, thus leaving no room for reasoning skills which can be used in problem solving. In fact, what seems to be done by the curriculum developers of the 1988 program is that the set-theoretic structure represented in the 1976 curriculum has been collapsed. Thus the resulting curriculum is not only inappropriate for local conditions but also for the modern technological world.

In summary, then, we can see that, despite the aims of ESR to attain equality and opportunity as well as enabling students to solve problems in their real life, the secondary mathematics curriculum remains inappropriate. So what then are be the possibilities for a curriculum which would take into account the aims of ESR? The answer to this question is not simple, especially when we consider the kind of challenge which Nyerere (quoted in Okoh, 1980) puts forward:

> From our traditional African society we inherit concepts of equality, democracy and socialism as well as economic backwardness. From the colonial period we inherit concepts of arrogant individualism and competition as well as knowledge about technical progress. It is our teachers who have the real power to determine whether Tanzania

> will succeed in modernizing the economy without losing the attitudes which allowed every human being to maintain his self respect, and earn the respect of his fellows while working in harmony with them.

Thus the challenge is to develop a secondary mathematics curriculum which will preserve the traditional values as well as utilize the power of academic mathematics. This challenge begs the question of the importance of cultural context to mathematics education. The literature indicates a number of studies focusing on "ethnomathematics", a term coined by D'Ambrosio (1985) to refer to mathematics which is practised among identifiable cultural groups (Abraham and Bibby, 1988). The vision of the ethnomathematics perspective is that the "psychological blockage" often associated with the learning of academic mathematics might be avoided (Gerdes, 1986). One of the main strategies therefore embodied in the curriculum to give effect to the above perspective is to utilize indigenous mathematics, for example, of basket weavers, hut builders etc., as a bridge into school mathematics (Taylor, 1991). A number of authors have pointed to the problems of this approach (Ernest, 1991, Taylor, 1991, Abraham and Bibby, 1988). Taylor, for example, has pointed to the issue of how appropriately the codification (academic mathematics) relates to its commonsense correlate (ethnomathematics). Abraham and Bibby, however, pointing to the problem of ethnomathematics as that of "ghettoising a curriculum", bring out important points when they say:

> Unlike Gerdes, we do not want to define mathematics as ethnomathematics but neither do we wish to define it as academic mathematics. Mathematics is more than either of these. Mathematics is produced not only through "everyday experiences" untouched by academic influence, but also through the organised activity of particular social groups whose mathematical problems arise because of an historical conjuncture between the groups' structural role in society and the

> predominant mathematical paradigms of the time. We shall call this socially organised mathematical activity the social institution of mathematics.

For Abraham and Bibby, therefore, ethnomathematics is a necessary but not sufficient condition for a mathematics education which seeks to develop mathematics as cultural resource. For this to be sufficient, mathematics education should contain a critical dimension oriented towards making judgements about experiences on the basis of understanding how context influences those experiences. This will involve, for example, students critically comparing their non-formal types of mathematical thinking with the official version of mathematics presented to them. Abraham and Bibby go on to suggest that mathematics cannot be completely understood without some understanding of the social institution of mathematics. This means having an understanding of the human actions and commitments that give rise to major developments in mathematics. It means having an understanding of the role mathematics plays in structuring our experiences and judgements.

The above account helps us to understand the nature and purpose of the school mathematics. The nature of school mathematics is neither an established body of knowledge of procedures and facts nor an imposed hierarchy of knowledge but rather a socially organized activity growing by means of human actions and commitments. The purpose of school mathematics, then, is to enable students to understand how this activity is established and to critically relate this to understand their own experiences. In other words, understanding the power of mathematics. Thus, learning mathematics means doing mathematics or engaging in some mathematical activity having purpose.

The literature reviewed in Chapter 2 provides a vision of what could be the possibilities if the mathematics curriculum takes into account of the above discussion.

Therefore, some of the recommendations are identified below.

Recommendations

1. Secondary school mathematics curriculum should reflect the contribution of mathematics to the cultural development of a society. This will enable students to appreciate the mathematical traditions in their culture (ethnomathematics) which people carry and sustain in many ways. For example the mathematics of basket weavers, hut builders, fisherman, dairy herders, etc.

2. The contribution of mathematics to the cultural development also applies to formal and academic mathematics and its applications which is part of "social institution of mathematics" (Abraham and Bibby, 1988). Secondary school mathematics curriculum should then include experiences which will provide students insights into mathematics as a symbolic system, as a record of human beings strivings and also as a way thinking and of communicating thought.

3. Problem solving must be a focus of the secondary school mathematics curriculum. This should be considered as a pedagogical approach to the whole curriculum and not as an addition to the content of mathematics.

4. Mathematics curriculum should include opportunities for students to learn to communicate mathematically. This can be done by utilizing the mathematical experiences in which students can read, write and discuss ideas.

5. Mathematics curriculum should include opportunities for the students to learn to reason mathematically. This will enable students to appreciate mathematics as a deductive system and also as concerned with patterns shapes and order.

6. This means that, while traditional content should be included in the curriculum, emphasis should be shifted from practice in manipulating expressions and practising algorithms to the use of real world problems to enable students to explore mathematics concepts and skills.

The teaching of mathematics

The situation

The concerns raised by the teachers who participated in this study help us to understand what could be the situation in the teaching of mathematics. The findings indicate the transmission - authoritative methods of teaching are the common methods used by teachers of mathematics in secondary schools. Some of the reasons for this observation were discussed in the previous sections in this chapter. These included the predominant discipline-oriented subject matter and the centralized model of curriculum development.

Very often attempts to bring changes in mathematics education in Tanzania have relied on changes in syllabuses and textbooks. And it has been expected from these changes that teachers' behaviour would change. The findings indicate that this is not normally the case. For, despite the changes which have been made in the secondary mathematics program, teachers still use the same approaches to teaching.

Another reason which was identified is the way teachers perceive the nature of mathematics, mathematics learning and teaching. The findings indicate that most teachers have a restricted view of what constitutes the content of mathematics. For most of the teachers, the findings indicate that teaching mathematics involves giving an example of how to solve the problem and giving similar exercises.

Another factor identified was that of the effect of examinations. Because of this, most teachers are concerned with the coverage of curriculum content that will be tested. They adapt their teaching in order to prepare their students for examination. The role of examinations as a means of assessing progress continues to create problems in the teaching of mathematics in Tanzania. Because of the limited opportunities of post secondary education, selection depends on the examination performance where students have to compete against one another. The findings from the teachers' concerns indicate that assessment in classrooms is often no more than recording marks of students. For example, most teachers record marks of students every time they mark homework. Also, in handling homework, most of the teachers discuss difficult questions in their classrooms. Thus there is no indication of one-to-one communication between the teacher and student.

Recommendations

1. Some of the recommendations have been given in the previous sections. These include redefining the secondary school curriculum and substantial decentralization to empower teachers with the process of program development.

2. However the redefinition of the secondary school curriculum and empowering teachers with decision making must be accompanied by parallel changes in the "culture" of teaching. For example the redefinition of the curriculum will require teachers to have knowledge of the cultural role of mathematics, knowlege of the critical contribution of mathematics to technology and science and ways of teaching mathematics to students from different sub-cultural orientations. This means that teachers will have to be able to use a variety of teaching methods beyond the transimission-authoritative methods of teaching.

3. There must be a provision of inservice courses to enable

teachers to work together in the interpretation of the guidelines provided by authority concerned. Teachers must be actively involved in the process of professional development in order to develop their confidence, motivation, autonomy and professionalism. This professional development must be recognised as a long term and contnuous process.

4. There must be a link between curriculum development and assessment. This means that the role of examinations should be reexamined. More student-based assessment and recording procedures which lead to the needs of the students should be explored. This will enable teachers to get feedback from their students.

Summary

Rethinking secondary mathematics education must include:

1. Redefining what is to count as the secondary mathematics curriculum in a way that recognises and rewards not only academic and intellectual achievements but also practical, aesthetic, personal and social achievements for all students.
2. Rethinking of the Program development process whereby curriculum development and decision making is substantially decentralized. It must be given to the teachers. However, this must have sufficient scope to allow teacher development. Also there must be a set of centrally produced guidelines directing teachers to provide the kind of curriculum mentioned above.
3. Rethinking of the assessment procedures so as to allow for student development.

In general, rethinking secondary mathematics education must include program development which will tie together curriculum, assessment, teachers' and students' development.

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APPENDIX A

A COMPARISON OF THE SMP, ENTEBBE, NATIONAL 1976, NATIONAL 1988 O'LEVEL MATHEMATICS SYLLABUS

A COMPARISON OF THE S.M.P, ENTEBBE, NATIONAL 1976, NATIONAL 1988 O' LEVEL MATHEMATICS SYLLABUSSES

	S.M.P	ENTEBBE	1976	1988
Sets, union, intersection, subset. Universal set, compliment. Venn diagrams.	X		X	X
Relations, correspondence, mapping.		X	X	X
Functions, domain, range, composition of funtions. Inverse, linear, quadratic, polynomial, rational, absolute value, exponential, logarithmic and step functions. Square root and trigonometrical funtions.		X	X	X
Numbers: Integers, ratonals, reals, properties of the number system.		X	X	X
Factors, multiples, primes. Integral exponents, roots.				
Modular arithmetic.		X		
Number bases other than ten.	X	X	X	X
Approximations, degree of accuracy. The slide rule. Standard form.		X	X	X
Finite sequences, A.P, G.P.		X	X	X
Fractions, decimals, percentages. (profit and loss). Proportion, ratio.	X	X	X	X
Reasoning: implication, equivalence, valid argument.	X			
Logarithms, use of tables.		X	X	X
Laws of exponents (as theorems).		X		X
Systems of weights and measures, metric and other.	X	X	X	X
Simple interest.		X		
Statistics. Graphs and charts. Mean, median and mode.	X	X	X	X

	S.M.P	ENTEBBE	1976	1988
Inqualities, linear, simultaneous (in one variable).	X	X	X	X
Quadratic inequalities		X		
Graphs of functions (linear and quadratic) Graphical solutions of equations. Interpretation of a graph.	X	X		
Conditional and identical equations.	X		X	
Exponential law of growth. Linear, square and reciprocal relationships.	X			
Gradients of graphs, by drawing	X		X	X
Estimation of area under a curve.	X			
Linear programming, application of inequalities.	X		X	X
Scale drawings. Plan and elevation maps. The earth as a sphere, latitude, longitude	X	X	X	X
Orthogonal projection	X	X	X	X
Cartesian co-ordinates. Transformations in the plane; reflection, rotation, translation, stretching, shearing. Symmetry	X		X	
Properties of triangles, quadrilaterals, parallelograms, circles.	X	X	X	X
Mensuration, areas and volumes. Triangle, quadrilateral, prism, pyramid, cone, sphere.	X	X	X	X
Geometric constructions; perpendiculars, bisectors of angles and line segments. circles		X	X	X
Development of Euclidean geometry (from axioms). Deductive reasoning in geometry. Co-ordinate geometry an introduction.		X	X	X

	S.M.P	ENTEBBE	1976	1988
Introduction to probability	X	X	X	X
Linear kinematics, rates		X	X	X
Formulae, variation. Factors $ab \pm ac$ $a^2 - b^2$	X		X	X
Expansion of expressions, a(b+c)	X	X	X	X
Factors of trinomials, $ax^2 + bx + c$	X	X		
Equations, linear, simultaneous linear		X	X	X
Quadratic equations (by factors)	X	X	X	X
Locus problems		X	X	X
Vectors, sum and difference, scalar multiple.	X	X	X	X
Pythagoras' theorem. Sine, cosine and tangent of the angle	X	X	X	X
Trgonometrical identities	X			
Matrices (2x2) as linear transformations. Matrix multiplication. Unit matrix, inverse matrix, applications.	X		X	X

APPENDIX B

A FRAMEWORK FOR ANALYSING THE CURRICULUM MATERIALS

APPENDIX B

A FRAMEWORK FOR ANALYSING THE CURRICULUM MATERIALS

ANALYSIS OF THE SYLLABUSES

Four syllabusses will be analysed, Entebbe, S.M.P, National 1976 and National 1988. The following questions will be used in the analysis of each of the above syllabusses.

1. What are the major parts of the syllabus:

   a. A list of the topics or themes

   b. Recommended sequences and time specifications for teaching the topics or themes.

   c. Recommended teaching strategies

2. What is the rationale of the curriculum, as stated by its developers?

   a. The nature of the subject matter

   b. How the subject matter is related to other disciplines

   c. The relation of the program to general or specific educational goals

   d. Suggested teaching strategies and their appropriateness for different student population

   e. The anticipated role of teachers using the materials.

ANALYSIS OF THE TEXTBOOKS FOR ENTEBBE, S.M.P, NATIONAL 1976 AND NATIONAL 1988:

Two exemplary topics (chapters) from textbooks of each of the syllabusses will be analysed, quadratic equations and coordinate geometry. The textbooks will be analysed in the light of four factors influencing curriculum; subject matter, learner, milieu and teacher. The following questions will guide the analysis:

1. The subject matter:

   a. To what extent does the textbook present and emphasize specific information, concepts, principles

and skills.
b. How does the textbook present the relationship between mathematics and every day life
c. How does the textbook present the image of the mathematician.
d. How does the textbook present the integration of mathematics with other disciplines

2. The learner:
   a. How does the textbooks present the image of the learner; passive or active

   b. What opportunities are offered by the texbook for learner development; cognitive, affective and psychomotor.

   c. What is the intended focus of instruction? Is the learner percieved as an individual with particular needs and interests or as a member of the group with shared interests and needs?
   d. What learning styles are presented in the textbooks? Unstructured or structured learning environments?

3. Milieu:

   a. How does the textbooks reflect the interaction between society and the mathematics discpline

   b. How does the textbooks reflect the interaction between society and the process of curriculum development

4. The teacher

   a. How do the developers' considerations communicated to the teachers in the textbooks

   b. To what extent is the degree of teacher autonomy presented in the textbooks

      - To what extent are the specific objectives stated?
      - To what extent are the teaching strategies specified?
      - To what extent are teachers offered teaching alternatives?

   c. What teacher's role in instruction is presented in the textbooks?

   d. How are the teachers' needs presented in the textbooks? Eg. difficulties, opinions, attitudes.

APPENDIX C

QUESTIONNAIRE TO SECONDARY MATHEMATICS TEACHERS

APPENDIX C

QUESTIONNAIRE TO SECONDARY MATHEMATICS TEACHERS:

1. This questionnaire is designed to obtain basic information about the experiences of teachers involved in the teaching of the Tanzanian secondary school mathematics. The information will be used in a research project intended to analyze the present secondary school curriculum in view of making recommendations on new directions and possibilities in future curriculums.

2. You are invited to participate in the project by completing this questionnaire. You are encouraged to be frank and forthright in making your responses and are assured that all returns will be treated **confidentially.**

3. The questionairre consists of four major parts:

   Part 1: Background information **(Your background)**

   Part 2: Curriculum **(The situation in your school)**

   Part 3: Obstacles **(Experienced by mathematics teachers in general)**

   Part 4: Recommendations **(What are the possibilities)**

PART I: BACKGROUND INFORMATION

For each question, circle the letter of the appropriate response:

1. What is the type of school you are currently teaching?

   a. Girls' school

   b. Boys' school

   c. Co-Education school

2. What is your sex?

   a. Male

   b. Female

3. What is your age?

   a. Under 26

   b. 26 - 35

   c. 36 - 45

   d. 46 - 55

   e. Over 55

4. What is your professional education?

   a. Diploma in Education

   b. Bachelor of Education

   c. Bachelor of Science (Education)

   d. Other (Please specify) ______________________

5. In what institution did you obtain your professional education? (please specify)

   ____

6. How many years of teaching experience do you have?

   a. 1 year

   b. 2 - 5 years

   c. 6 - 9 years

   d. 10 - 13 years

   e. 14 years or over

7. What other subjects do you teach (other than mathematics)

   a. Physics

   b. Chemistry

   c. Biology

   d. Other (please specify) ______________________

8. How many school subjects are you teaching at present?

   a. 1

   b. 2

   c. 3

   d. Other (please specify) ______________________

9. In the current school term, how many different students are you teaching?

   a. Less than 50

   b. 50 - 99

   c. 100 - 149

   d. 150 - 199

   e. 200 or more

10. In the current school term, what percentage of your teaching load is comprised of teaching mathematics?

    a. Less than 20%

    b. 20% - 39%

    c. 40% - 59%

    d. 60% - 79%

    e. 80% - 100%

11. What percentage of your teaching mathematics load is comprised of teaching each of the following grades?

    a. Form one ______________%

    b. Form two _____________%

    c. Form three____________%

    d. form four_____________%

    e. A' level _____________%

12. How do you rate the adequacy of your background for implementing the overall goals of secondary mathematics in Tanzania?

    a. Very good

    b. Good

    c. Satisfactory

    d. Unsatisfactory

    e. Very unsatisfactory

PART 2: THE CURRICULUM

1. All questions below refer to the current O' level mathematics curriculum. Please indicate the level you usually teach.

   a. O' Level

   b. A' Level

2. What syllabus did you use when you started teaching?

   a. The Entebbe Mathematics

   b. The School mathematics for East Africa

   c. The National Secondary mathematics syllabus

   d. The new National O' level mathematics syllabus

   e. Any other (please specify) ____________________

3. Has it changed ?

   a. Yes

   b. No

If the answer to (3) above is yes then answer question (4)

4. How was/were the new syllabus(ses) communicated to you?

   a. Through Head of school or staff meetings

   b. Through attendance at inservice courses

   c. Through informal talks with other teachers.

   d. Through staffroom notice board

   e. Through Education circulars

   f. Through visiting other schools

   g. Other (please specify) ____________________

5. In your opinion what seems to be the common method by which new syllabuses are communicated to teachers in your school?

____

6. Please list the books which are currently used for teaching mathematics in Forms one to four.

Title and author	Form	teacher or student text

____

7. Please list down any workshops meetings or seminars you have attended in connection with the teaching of mathematics.

Title of workshop	organized by	Issues addressed

8. Please rate the **importance and difficulty for the students** and **interest in teaching,** the mathematics teachers in your school in general, find in each of the following listed topic areas using the scale given below:

Scale: 1 - very important/very difficult/very interesting

2 - fairly important/fairly difficult/fairly interesting

3 - of little importance/ of little difficulty/ of little interest

4 - not important/not difficult/not interesting

Please answer each column separately.

FORM ONE:

Topics	Do teachers think this topic important for the students in this form Importance	Do students find this topic difficult? Difficulty	Is this topic intere_ sting to teach? Interest
a. Numbers	1 2 3 4	1 2 3 4	1 2 3 4
b. Fractions	1 2 3 4	1 2 3 4	1 2 3 4
c. decimals	1 2 3 4	1 2 3 4	1 2 3 4
d. percentages	1 2 3 4	1 2 3 4	1 2 3 4
e. Units	1 2 3 4	1 2 3 4	1 2 3 4
f. Approximation and accuracy	1 2 3 4	1 2 3 4	1 2 3 4
e. Geometry	1 2 3 4	1 2 3 4	1 2 3 4
f. Algebra	1 2 3 4	1 2 3 4	1 2 3 4
g. Statistics	1 2 3 4	1 2 3 4	1 2 3 4
h. Coordinate Geometry	1 2 3 4	1 2 3 4	1 2 3 4
i. Real numbers	1 2 3 4	1 2 3 4	1 2 3 4
j. Perimeters and areas	1 2 3 4	1 2 3 4	1 2 3 4
k. Ratio and rate	1 2 3 4	1 2 3 4	1 2 3 4
l. Variation	1 2 3 4	1 2 3 4	1 2 3 4

FORM TWO:

Topic	Do teachers think this topic important for the students in this form? Importance	Do students find this topic difficult? Difficulty	Is this topic intere-sting to teach? Interest
a. Algebraic expressions and equations	1 2 3 4	1 2 3 4	1 2 3 4
b. Quadratic Equations	1 2 3 4	1 2 3 4	1 2 3 4
c. Congruence	1 2 3 4	1 2 3 4	1 2 3 4
d. Similarity	1 2 3 4	1 2 3 4	1 2 3 4
e. Pythagoras theorem	1 2 3 4	1 2 3 4	1 2 3 4
f. Enlargement	1 2 3 4	1 2 3 4	1 2 3 4
g. Exponents	1 2 3 4	1 2 3 4	1 2 3 4
h. Radicals	1 2 3 4	1 2 3 4	1 2 3 4
i. Logarithms	1 2 3 4	1 2 3 4	1 2 3 4
j. Trigonometrical ratios	1 2 3 4	1 2 3 4	1 2 3 4
k. Vectors	1 2 3 4	1 2 3 4	1 2 3 4
l. Sets	1 2 3 4	1 2 3 4	1 2 3 4
m. Locus	1 2 3 4	1 2 3 4	1 2 3 4
Others:			
n. ______________	1 2 3 4	1 2 3 4	1 2 3 4
o. ______________	1 2 3 4	1 2 3 4	1 2 3 4

FORM THREE:

Topic	Do teachers think this topic important for the students in this form? Importance	Do students find this topic difficult? Difficulty	Is this topic intere_ sting to teach? Interest
a. Sequences and series	1 2 3 4	1 2 3 4	1 2 3 4
b. Relations	1 2 3 4	1 2 3 4	1 2 3 4
c. Functions	1 2 3 4	1 2 3 4	1 2 3 4
d. Kinematics	1 2 3 4	1 2 3 4	1 2 3 4
e. Circles	1 2 3 4	1 2 3 4	1 2 3 4
f. Spheres	1 2 3 4	1 2 3 4	1 2 3 4
g. Plan and Elevation	1 2 3 4	1 2 3 4	1 2 3 4
h. Statistics	1 2 3 4	1 2 3 4	1 2 3 4
Others:			
i.________________	1 2 3 4	1 2 3 4	1 2 3 4
j.________________	1 2 3 4	1 2 3 4	1 2 3 4
k.________________	1 2 3 4	1 2 3 4	1 2 3 4

FORM FOUR:

Topic	Do teachers think this topic important for the students in this form? Importance	Do students find this topic difficult? Difficulty	Is this topic intere-sting to teach? Interest
a. Coordinate Geometry	1 2 3 4	1 2 3 4	1 2 3 4
b. Linear Programming	1 2 3 4	1 2 3 4	1 2 3 4
c. Areas and Volumes	1 2 3 4	1 2 3 4	1 2 3 4
d. Trigonometry	1 2 3 4	1 2 3 4	1 2 3 4
e. Vectors	1 2 3 4	1 2 3 4	1 2 3 4
f. Three Dimensional Geometry.	1 2 3 4	1 2 3 4	1 2 3 4
g. Matrices and Transformation.	1 2 3 4	1 2 3 4	1 2 3 4
h. Probability	1 2 3 4	1 2 3 4	1 2 3 4
Others:			
i. ____________	1 2 3 4	1 2 3 4	1 2 3 4
j. ____________	1 2 3 4	1 2 3 4	1 2 3 4
k. ____________	1 2 3 4	1 2 3 4	1 2 3 4

9. In this section you are asked to indicate **how frequently**, mathematics teachers in your school in general, **use particular teaching methods** in their teaching of mathematics. Use the following scale:

    1 - Never

    2 - About once or twice during the unit (topic)

    3 - About once or twice during the week

    4 - Almost every class period.

    5 - Other (please specify)

    a. Lectures 1 2 3 4 5 _______________

    b. Teacher demonstration 1 2 3 4 5 _______________

    c. Class discussion (ie teacher/class dialogue 1 2 3 4 5 _______________

    d. Small group activities 1 2 3 4 5 _______________

    e. Student directed class discussion 1 2 3 4 5 _______________

    f. Have students practice problems independently 1 2 3 4 5 _______________

    g. Teacher Boardwork 1 2 3 4 5 _______________

    h. Student Boardwork 1 2 3 4 5 _______________

    i. inquiry based activities 1 2 3 4 5 _______________

    j. Tests or quizzes 1 2 3 4 5 _______________

10. In this section you are asked to indicate **how frequently**, mathematics teachers in your school in general use particular **methods in handling completed homework**. Please use the scale in no. 9 above.

    a. Collect it to mark it personally 1 2 3 4 5 ________

    b. Read answers in class 1 2 3 4 5 ________

    c. Display answers in class 1 2 3 4 5 ______

d. Display answers and methods in class 1 2 3 4 5 ______

e. Discuss difficult questions 1 2 3 4 5 ______

f. Have students discuss methods 1 2 3 4 5 ______

g. Record a mark of student perfomance 1 2 3 4 5 ______

Others:

h. ________________________________ 1 2 3 4 5 ______

i. ________________________________ 1 2 3 4 5 ______

j. ________________________________ 1 2 3 4 5 ______

11. In this section you are asked to indicate how **certain factors influence** mathematics teachers in your school in general, in **planning mathematics lessons**. Use the scale provided below:

1 - Probably the most influence

2 - An important influence

3 - A moderate influence

4 - Of little influence

5 - No influence

a. What students require in order to understand the historical development of mathematics. 1 2 3 4 5

b. What students will enjoy and find personally interesting. 1 2 3 4 5

c. What students find easy to understand. 1 2 3 4 5

d. The students' ability. 1 2 3 4 5

e. The time available. 1 2 3 4 5

f. Approaches that have worked well for them in the past. 1 2 3 4 5

g. The material builds on or extends concepts covered in previous grades 1 2 3 4 5

h. Their interests, background and

preferences. 1 2 3 4 5

i. What society needs by way of informed citizen 1 2 3 4 5

12. In this section you are asked to rank the **factors**, mathematics teachers in your school in general, consider in **priotizing their lesson objectives**, from most influencial (1) to least influencial (5) for each form.

	Form 1	Form 2	Form 3	Form 4
a. What students need to know in their daily lives				
b. What students need to know to pass the examination.				
c. What the syllabus specifies				
d. What the text book specifies.				
e. What students need to know to understand the structure of mathematics.				

13. Do mathematics teachers in your school in general, find the time allocated to cover the mathematics curriculum for form 1 - 2 and form 3 - 4. Please tick the right response for each category.

	Form 1 - 2	Form 3 - 4
a. not sufficient		
b. just sufficient		
c. more than sufficient		

14. If your answer to no. (13) above is (a) or (c), how much time would you allocate for form 1 - 2 and form 3 - 4 mathematics in hours per week (please specify)

Form 1 - 2: ______________________________

Form 3 - 4: ______________________________

15. How would you like the time allocated for math to be distributed in each lesson?

a. 40 minutes per lesson

b. 80 minutes per lesson

c. Other (please specify) __________________________

16. On the average, what percent of form two students in your school pass the National form two mathematics examination?

a. Less than 20%

b. 20% - 34%

c. 35% - 44%

d. 45% - 54%

e. 55% - 70%

f. more than 70%

Any comments____

____

____

17. On the average, what percent of form four students in your school pass the National form four mathematics examination?

   a. Less than 20%

   b. 20% - 34%

   c. 35% - 44%

   d. 45% - 54%

   e. 55% - 70%

   f. More than 70%

   Any comments ______________________________________

   ____

   ____

PART 3: THE OBSTACLES

1. In this section you are asked to indicate how serious are the problems experienced by teachers in general in implementing the mathematics curriculum. Use the scale provided below:

   1 - Extremely serious

   2 - Very serious

   3 - Somewhat serious

   4 - Observed but not serious

   5 - Not observed by me

a. Textbooks concerns:

i. Language	1 2 3 4 5
ii. Density of concepts	1 2 3 4 5
iii. Abstractness	1 2 3 4 5

b. Problems of teaching resources:

i. Insufficient	1 2 3 4 5

ii. Misuse of the available 1 2 3 4 5

c. Syllabuses:

i. Inappropriate topics 1 2 3 4 5

ii. many topics 1 2 3 4 5

iii. Difficult topics 1 2 3 4 5

iv. Sequence not conducive to learning 1 2 3 4 5

d. Classrooms:

i.Overcrowdedness 1 2 3 4 5

ii. Not conducible to learning 1 2 3 4 5

e. Time allowed:

i. Inadequate 1 2 3 4 5

ii. Not utilized 1 2 3 4 5

f. Teacher concerns:

i. Lack of inservice courses 1 2 3 4 5

g. Students concerns:

i. Language problem ie English as a second language 1 2 3 4 5

ii. Poor background 1 2 3 4 5

iii.Social background 1 2 3 4 5

iv. Wide ability range 1 2 3 4 5

Others:

h.____ 1 2 3 4 5

i.____ 1 2 3 4 5

j.____ 1 2 3 4 5

k.____ 1 2 3 4 5

2. What are the three most serious problems experienced by teachers in your school in teaching mathematics?

   1. ______________________________

   2. ______________________________

   3. ______________________________

PART FOUR: RECOMMENDATIONS

1. In this section you are provided with different **reasons of teaching mathematics** in schools. Please indicate the emphasis **that should be given** for each of the reasons using the scale provided below:

   1. much more emphasis
   2. somewhat more emphasis
   3. about the same emphasis
   4. somewhat less emphasis
   5. much less emphasis

a. To think logically	1 2 3 4 5
b. To solve problems in everyday life	1 2 3 4 5
c. To gain skills necessary for employment	1 2 3 4 5
d. To preserve students options with respect to potential careers and voational choices	1 2 3 4 5
e. To teach skills necessary for continued work in mathematics	1 2 3 4 5
f. To develop understanding of the structure of mathematics	1 2 3 4 5
g. To develop skills for further studies	1 2 3 4 5
h. To assure an adequate supply of scientists and engineers	1 2 3 4 5
i. To preserve traditional part of schooling	1 2 3 4 5

j. To provide skills to study science related subjects. 1 2 3 4 5

k. To stimulate curiosity and intellectual excitement. 1 2 3 4 5

l. To convey an appreciation of mathematics as a deductive system. 1 2 3 4 5

m. To convey an appreciation of mathematics as concerned with patterns, shapes and order. 1 2 3 4 5

n. To provide insights into mathematics as expression of Man's intellect and of Man's historical development. 1 2 3 4 5

o. To provide insights into mathematics as Man's abstracting of nature 1 2 3 4 5

p. To provide insights into mathematics as a way of thinking and communicating thought. 1 2 3 4 5

Others:

q.____ 1 2 3 4 5

r. _______________________________________ 1 2 3 4 5

s. _______________________________________ 1 2 3 4 5

2. What are the three most important reasons for teaching mathematics?

    1. ____________

    2. ____________

    3. ____________

3. The following are some possible **classroom orientations** for the content of secondary mathematics in Tanzania. **Which would you recommend**. Use the following scale:

    1 Strongly recommend

    2 Just recommend

    3 Undecided

    4 Not recommend

5 strongly not recomend

The mathematics curriculum should include opportunities for

a. the teacher and students to spend class time dealing with end of chapter word problems. 1 2 3 4 5

b. the teacher and students to spend class time dealing with non-routine, hard problems. 1 2 3 4 5

c. for the students to express mathematical procedures and solutions to the teacher and other students. 1 2 3 4 5

d. for the teacher to show different symbolic ways for representing formulas and procedures. 1 2 3 4 5

e. for the teacher and students to spend class time on explanations and proofs that would reinforce accurate thinking. 1 2 3 4 5

f. for time to be spend on students explaining in detail how they developed a solution to a problem. 1 2 3 4 5

g. for the teacher to spend time showing how different mathematics topics interact with other mathematics topics, such as trigonometry and similar triangles. 1 2 3 4 5

h. for the teacher to spend class time showing additional alternative solutions to problems. 1 2 3 4 5

i. for the teacher to spend class time showing specific practical application of mathematics such as conservation of resources, constructing roads etc. 1 2 3 4 5

j. for the students to develop skills in estimation and approximation. 1 2 3 4 5

k. for the students to develop sense of numbers. 1 2 3 4 5

l. for calculators to be introduced in secondary schools but postponed until students have learned both the meaning of, and paper and pencil procedures for number computation. 1 2 3 4 5

4. In this section you are provided with statements about **resources** for use in mathematics classrooms. Please indicate the emphasis for each one of the statements **should receive** using the scale below:

1 much more emphasis

2 somewhat more emphasis

3 about the same emphasis

4 somewhat less emphasis

5 much less emphasis

a. Students worksheets or workbooks should be included for drill and practice at the conlusion of each lesson 1 2 3 4 5

b. Activities should be included that anticipate the class being divided into small groups. 1 2 3 4 5

c. Tests, homework and specific objectives should be included to encourage each student to attain specified competency level. 1 2 3 4 5

d. Only problems which students can answer quickly should be assigned. 1 2 3 4 5

e. Ideas or procedures should be developed through real life problems, situations or activities. 1 2 3 4 5

f. Detailed notes should be provided to guide the teacher in oral presentations of the lessons. 1 2 3 4 5

g. Short problem solving sections should be included after each mathematical topic is taught. 1 2 3 4 5

h. Physical materials, which the students can manipulate to help them understand mathematical ideas should be included in many lessons. 1 2 3 4 5

i. Diagrams should be emphasized in textbooks and other materials. 1 2 3 4 5

5. In this section you are provided with statements about **teaching strategies** used in mathematics classrooms. Which strategies **would you recommend**. Use the following scale:

1 strongly recommend

2 just recommend

3 no opinion

4 not recommend

5 strongly not recommend

a. More than fifty percent of instructional time is devoted to drill and pactice. 1 2 3 4 5

b. Many new mathematical topics are introduced with a problem to be solved. 1 2 3 4 5

c. More than fifty percent of the instructional time is devoted to student use of individual study materials to develop and extend ideas. 1 2 3 4 5

d. Basic ideas are introduced through investigations or experiments with materials. 1 2 3 4 5

e. Students are to read about mathematical ideas before classroom activities are devoted to these ideas. 1 2 3 4 5

f. Most lessons are designed to be conducted with a single large group. 1 2 3 4 5

g. Daily homework assignment are included. 1 2 3 4 5

h. Students are shown how to solve a problem and then similar practice problems are assigned. 1 2 3 4 5

i. Most lessons are designed to provide opportunities for student discussions. 1 2 3 4 5

j. Activities are included which require group work. 1 2 3 4 5

6. In this section you are asked to **assign priorities** for the attention to each of the broad areas of **improving secondary mathematics** in Tanzania. Use the scale below:

   1 highest priority

   2 second highest priority

   3 middle level priority

   4 second lowest priority

   5 lowest priority

   a. Improvement of preservice and inservice teacher education. 1 2 3 4 5

   b. Improvement of methods and techniques for teaching mathematics. 1 2 3 4 5

   c. Development of special materials for students with special needs. 1 2 3 4 5

   d. Development of materials other than textbooks. 1 2 3 4 5

   e. Improvement of mathematics textbooks. 1 2 3 4 5

   f. Improvement of school conditons. 1 2 3 4 5

   g. Revision of the syllabus. 1 2 3 4 5

   h. Increase of secondary school enrollment. 1 2 3 4 5

7. What are the three areas which need immediate attention?

   1. ______________________________

   2. ______________________________

   3. ______________________________

8. Any general comments to the questionairre you have filled.

____

____

____

____