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FINAL REPORT

to the

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

THE AFRICAN MATHEMATICS PROGRAM

Contract No. res/21 and csd/1567

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Education Development Center
55 Chapel Street
Newton, Massachusetts

April 2, 1971

AFRICAN MATHEMATICS PROGRAM

FINAL REPORT

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AFRICAN MATHEMATICS PROGRAM

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AFRICAN MATHEMATICS PROGRAM

Final Report

The African Mathematics Program was initially funded on June 12, 1961 and activities in Africa ceased on December 31, 1970. During this period, the Program held workshops for production of materials, published and distributed textbooks which were given classroom trials, and teacher training institutes were held to prepare teachers to use the books in these classroom trials. The main funds of the Program have been obtained from USAID under Contract res/21 and csd/1567 to the amounts of $1,823,012 $1,034,286 respectively. Three additional grants of $20,000, $25,000, and $372,000 were given by Ford Foundation to assist in the costs of the first workshop and the publication of its materials, and a planning meeting for the development of a leadership training project (the ABC Institute).

INTRODUCTION

The January 1970 report was a detailed description of all the activities of the Program held to that date. In the report, a full description was given on the participation in the workshops, materials which were produced, the number of publications and the distribution of those publications and the extent of the classroom trials, the number of institutes and the participation in the institutes preparing teachers to use the books experimentally. A final supplement to this detailed report was presented in October 1970. This present report will not go over this ground again.

It will take a broader view of the Program and will describe what early decisions were made by the Steering Committee based on their educational thinking and their estimates of the needs of African mathematics at that time. Decisions forced on the Program under pressure of African educators will also be described. The report will consider how these early decisions affected the operation of the Program throughout the whole period.

The development and maintenance of working relationships with African Ministries of Education will be discussed. Consideration will also be given to our own evaluation of our activities, our successes and partial successes and failures, the evaluation of others and the impact of the Program in Africa as we see it.

BACKGROUND OF THE PROGRAM

The aims of the Program were based on our knowledge of the state of African mathematics at the time of the initiation. This knowledge came partly from the discussions with African educators at the Endicott House Conference in 1961 and knowledge of Africa from personnel within the Program. The aims were later redefined as a result of discussions with African participants at the first workshop in 1962.

At that time traditional mathematics was being taught in all of the African countries. At secondary level most of this teaching was undertaken by expatriate teachers. Primary education on the other hand had been almost completely Africanized except for primary teacher training. In many places up to 50 percent of the African primary school teachers were untrained. Many of these untrained teachers had themselves only received a primary education.

A large proportion of the remainder of the teachers in the primary schools had a basic primary school education plus two or three years of teacher training. The training had been based on traditional mathematics of a most formal type in which they were encouraged to use a formal classroom setup, a Socratic method of teaching. The measure of success was the achievement of the students in formal internal or external examinations.

The vast changes in mathematics education which at that time were already having impact in many of the developed countries had not yet affected the African schools and indeed very few African mathematics educators or teachers were aware that these changes were taking place. The control of mathematical education policy was in the hands of small mathematics committees or a local inspectorate, the members of which seldom had experience in primary education or the developments in mathematics education in the previous ten years. These people were mainly either secondary school teachers transferred into administrative posts or expatriate teacher trainers, who had a good knowledge of what actually happened in the classrooms, but were seldom well-qualified mathematically and who were imbued with a feeling for a traditional approach to mathematics education.

Neither African mathematicians nor expatriate mathematicians from universities were involved in setting mathematics educational policy. In most countries the mathematics courses at primary and secondary level were set by the particular textbook which the ministry selected for use in all schools. This was certainly so in all primary schools. At secondary level, a choice of material was available but the choice was between two or three very traditional texts which had been in existence for twenty years or more and had been reissued in frequent "new" editions.

The influence of foreign publishers on education was very great. Sometimes these publishers would obtain the recommendations of the mathematical committees in the countries and make some attempt to satisfy what appeared to be local needs. As mentioned previously, the members of these committees were not always well-qualified mathematically. Sometimes representatives of the publishing companies were able to get themselves nominated to positions on the decision-making committee.

AIMS

It was with an awareness of these conditions that the African Mathematics Program developed its aims and made some of its early decisions.

The aims of the Program were:

1. To help African mathematics educators to become aware of the development of mathematics education in the U.S. and England;

2. To give them an opportunity of assessing the value of this new education in an African context;

3. To help the African countries to develop an ability to make such assessments;

4. To give African mathematics educators experience in developing curriculum materials to be used on an experimental basis;

5. To encourage the active participation of children in the learning process;

6. To involve African university mathematicians in school education so that ministries would have the benefit of their experience and competence in making mathematical decisions;

7. To give African mathematics education the benefit of the experience of U.S. mathematicians who had been involved in the development of new curriculum in the U.S.

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PROCESS

A. Workshops

To achieve these aims, the Program had eight workshops which were attended by 186 participants, 102 African and 84 American and others. From these workshops textual material for a full primary school course and two secondary school courses were prepared. In addition special texts were prepared for teacher training colleges, for additional mathematics courses at the O Level and for advanced mathematics courses at the A Level. Sixty-seven volumes (31 student text and 36 teachers' guide) were published and distributed. Approximately 515,000 of these books have been distributed in Africa and to other countries, organizations and individuals who have shown interest in the Program. Nearly 460,000 of this total were sent to African Ministries of Education.

B. Classroom Trials

At the latest date of full detailed information, 1967, these materials were being tried out in 3,400 classes. The trials were carried out in all classes from grade 1 through grade 13 as well as in teacher training colleges.

C. Teacher Training Institutes

Seventy-three teacher training institutes were held to prepare teachers for the use of the experimental texts. In all cases, these institutes were organized by the African Ministries of Education. The staff of the institutes were Africans who had been involved in the Workshops or the ABC Institute. They were assisted on most occasions by a visiting lecturer from the U.S. who was made available through the Program.

A full detailed report of the workshops, book distribution and institutes will be found in the January 1970 report.

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EARLY DECISIONS

Some of the early decisions based on our understanding of African needs affected:

A. Sending of African for overseas studies;

B. The use of expatriates;

C. The need for commitment by African Ministries of Education.

A. Overseas Study

At a very early date the Steering Committee decided that it was not the responsibility of the Program to organize overseas study for African mathematics educators. This decision was not made because it was felt in general unwise for Africans to go overseas for such study. There were, however, other organizations already responsible for such selections and placing of Africans in educational institutions abroad. It was our experience that seldom would the returning students come back to the tasks for which they were supposed to have been prepared. The need of African countries for educated personnel in general, and mathematicians in particular, was such that it seemed unlikely that within the period of the Program such people would be available to carry on or assist in the work of the Program. It was, therefore, decided that the Program would undertake "on-the-job" training and try to ensure that there were sufficient numbers of people trained in situ, so that the transfer and upgrading of some would not result in the collapse of activity.

B. Use of Expatriates

Even at that time, some doubt had arisen about the value of putting expatriates in positions of Program responsibility in African countries. Prior experience seemed to indicate that the appointment of such people inhibited

the appointment of nationals to assume positions of responsibility. This, on many occasions, resulted in the collapse of programs on the departure of the expatriate. Moreover, a major responsibility of the Program was to identify competent people and to give them an opportunity to assume responsibility under guidance which was not too close and authoritative.

C. Commitment

It was necessary that the African Ministries of Education should be made to feel that this Program was not a foreign Program imposed upon them but rather a Program which was theirs by choice, over which they had some control and into which they had put some of their resources. Thus the Program did not initiate any teacher training institutes. These institutes were always organized by the local Ministries of Education because they felt the need for training teachers to use the experimental texts. The Program, on request, assisted the Ministries with partial funding of the institutes and on most occasions by sending a visiting lecturer to assist local personnel whom the Ministries had released to teach at the institutes. Moreover, if they wished to participate in the Program, it was necessary for the Ministries to release teaching staff during term time in order to attend the workshops.

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EFFECT OF DECISIONS

Development of African Leadership and Commitment

The implementation of these decisions occasioned some very obvious results.

1. In the Steering Committee.* Very soon it was possible to add African university mathematicians to the Steering Committee of the Program. By the end of the Program all African university mathematicians who had been involved in the Program for any reasonable amount of time were members. Their role in the Steering Committee became more and more directive as the years went on. By 1966 when an executive committee was set up, the membership consisted of three Americans and three Africans.

2. At the Workshops. The early workshops achieved two purposes. In the first place they produced materials for the early grades at primary and secondary levels but they also served as "on-the-job" training for African mathematicians and teacher educators and teachers in the preparation of such materials. The African and non-African contributions in the first two workshops were very carefully reviewed and reorganized by American educators so that they could be produced in printed form. In the succeeding workshops the Program reaped the benefits of this process. From 1965 onward the Africans took a growing part in the decision-making processes of the workshops. Thus the chairman of the testing and evaluation group and the chairman of the secondary writing group were Africans from 1966 onward. African teachers and African personnel from institutes of education gradually assumed control of the small writing subcommittees of the primary writing group and another African became more and more responsible for the teacher training writing activities of the workshops. From 1966 onwards, an African was co-chairman of the total workshop.

*Appendix I. List of Members of Steering and Executive Committee

3. At the Institutes. All teacher training institutes were initiated, organized and mainly staffed by Africans who had been participants in the workshops. It was noticeable by 1966, as their confidence and knowledge of modern mathematics grew, the quality of lecturing and discussions in the seminar groups became better and better. From 1966 onward some countries occasionally held institutes without asking for the assistance of a visiting lecturer.

4. ABC Institutes. In a further effort to develop African leadership, the Program obtained funds from the Ford Foundation to develop what became known as the ABC Leadership Training Program. The purpose of this Project was to improve the mathematical background of the senior tutors of training colleges, of the mathematics administrators and of selected secondary school teachers and to give them the experience of working with African mathematicians from universities so that there would be available in each country a small core of people who would assist the workshop participants in advising the Ministries of Education of mathematics education. In addition, the ABC Institute provided these educators with a suitable background to enable them to introduce modern mathematics courses into their own colleges and to assist in the in-service training of other tutors from training colleges and teachers in service.

The outcome has been very satisfactory. Even during the training program very favorable reports were being received about the accomplishments of ABC participants at the teacher training institutes of the main program.* Some of the participants are already involved in the decision-making processes of mathematics education in their respective country.

* Appendix II. Excerpt from Prof. Vincent Haag's Report

The ABC Institute lasted two years during which time two 4-week sessions and one 2-week session were held at the University College of Nairobi. In addition to these residential sessions, there were two 10-month correspondence courses. The residential sessions took place during school holidays, and the correspondence courses during the academic year. This was, therefore, a fairly intensive "on-the-job" training program. One hundred participants attended the institute and of these 40 attended all three sessions.

5. The Use of African Mathematicians and Teachers. The leadership role of African participants of the workshop increased each year. As in the ABC Institute, an attempt was made at the workshops to give African teachers and educators experience in working with African mathematicians from universities. At the workshops secondary teachers, primary teachers and teacher trainers worked in small groups with the university mathematicians producing units. At the ABC Institues, seminar groups were organized on a national basis so that whenever possible, the local university mathematician was meeting regularly with his fellow nationalists, discussing mathematics, discussing the needs of their government and considering the teacher training needs. These relationships were reinforced by the Correspondence Course Program in which a university mathematician sent out assignments, corrected assignments and sent comments on assignments to the people in his own area. The benefits of this approach are now particularly obvious in the relationships between mathematicians and the education authorities in Sierra Leone, Ghana, Nigeria (Eastern Nigeria and Lagos), Ethiopia and Tanzania.

6. In-country Use of Workshop Participants. Very early in the Program some Ministries found it necessary to appoint a local person to supervise the classroom trials of the materials. These people, already devoted to the Program by reason of their participation in the workshops, very quickly became the spearhead for the wider use of the materials and for having curri-

cular reform in mathematics implemented throughout the countries.

By 1966 the advisory role of workshop participants was being accepted by some of the Ministries. Thus, the mathematics advisory committee of Sierra Leone consisted entirely of former workshop participants. A workshop participant in Liberia was in all occasions called to the Ministry to discuss matters of school mathematics. In Ghana a workshop participant was appointed to a Ministry position with a specific responsibility of supervising and guiding the teachers in elementary trial classrooms. In Western State of Nigeria a participant from the University of Ibadan assumed the responsibility of supervising the classroom trials. Later when this person was transferred to the University of Lagos she assumed a similar responsibility in Lagos. Similarly, in Eastern Nigeria a participant from the University of Nigeria was responsible for classroom trials. In Ethiopia the main pressure on the Ministry came from a participant from Haile Selassie I University. In Tanzania three participants, one inspector of schools and two teachers became the key personnel for the full-scale implementation which is now being carried out. In Malawi the inspector of schools practically on his own initiative made plans for classroom trials and the introduction of new mathematics into the training colleges. In Zambia a USAID technical advisor who had been a participant at the workshop assisted an inspector of schools who was responsible for the introduction of materials into the classrooms and for a far-ranging program for the training of tutors of colleges.

In all these situations the knowledge of modern mathematics and the assumption of responsibility was thus achieved by "on-the-job" training.

7. Country Commitment

After some initial difficulty arising from misunderstandings, e.g., problems of communcation between Americans, British and Africans and difficulties of Americans working in educational systems which were British

in origin, by the summer of 1963 all the participating countries were willing to release staff for the classroom trials and recognized the need for and initiated the necesary teacher training institutes. Approval was given for the expenditure of funds and for the use of personnel who in some cases would have been used for other purposes. As the Program developed, with no additional pressure, some countries organized more than one institute per year. In three cases long-term inservice training programs lasting throughout the year were organized. In this last instance, the Program itself was involved minimally and the activities were under the control of workshop and/or ABC participants.

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OTHER DECISIONS AND THEIR EFFECT

A. Production of Texts

As a result of the meetings with African mathematicians and educators at Endicott House and Accra in 1961 and at the first workshop in 1962 some firm decisions were made which affected the Program throughout its life. The most crucial of these decisions was the report of African mathematicians that the curriculum reform materials already developed in the U.S. were not suitable for immediate implementation in Africa and that it would be necessary to prepare textual materials especially for Africa. This decision led directly to the first workshop at Entebbe, Uganda in 1962 and directed the Program into a tremendous effort in producing the Entebbe Mathematics Series, a total of 67 volumes. In responding to this opinion the Program took its first step, which was continued throughout the Program, of listening to what Africans felt were African needs and trying to satisfy those needs with an awareness of the special conditions which existed in Africa.

B. Selection and Use of Workshop Participants

It was realized that the school texts could only be well prepared if African school personnel such as teachers, school administrators, teacher trainers and, of course, children were involved in the development of the materials. On the other hand, it was clear that there did not exist in Africa at that time sufficient experience in curriculum reform personnel to enable them to do the task unaided. Thus, participation in the first workshop included experienced mathematics educators from the U.S. and a

full representation of appropriate African educators. Even during the period of the first workshop preliminary materials were tried out in local classes. In accordance with purposes previously stated, writing groups were organized with a proper balance of American and African mathematicians and teachers.

C. Initiation of Formal Classroom Trials

During this first workshop a decision was made, under very strong pressure from African participants, that the classroom trials of the materials produced should be initiated on a fairly wide scale five months after the completion of the workshop. This particular decision gave rise to publication and distribution problems which lasted throughout the whole Program. Normal delays in publication, dock strikes and other difficulties of distribution made it extremely difficult to supply these initial trial classes each year with new materials as they moved up through the school. Moreover the pressure to produce a set of new materials for a full year each year made it very difficult to consider objectively the need for revisions on books already produced. There was neither money nor the time nor the personnel available to undertake both tasks efficiently. Moreover, teacher training institutes and some form of evaluation procedure became necessary although the Program was not at that time financed or prepared for such activities. Nevertheless, a considerable amount of revision was undertaken. Two volumes of Basic Concepts of Mathematics, the first of three years of secondary texts, and the Primary One texts were revised.

D. Substance and Methods

The level of ability of African primary teachers and the extent of t their basic education made necessary a careful study of the competence with which they were likely to deal with the new modern mathematics texts. Discussions at the first workshop made it clear that it would be necessary to devote a considerable amount of time to preparing Teachers' Guides which would have a heavy emphasis on the mathematical content of the primary school texts. Thus in most of the volumes produced the Teachers' Guides tend to be larger than the Pupil's Texts. Indeed, one of the main tasks of the Program has been to build up the mathematical ability of the teachers involved in the experimental program. Attention was also given to the introduction of good activity methods which involve the children in the learning process. The insecurity arising from the need to deal with new matter through activity and methods which were also new, was a matter of concern to the teachers and program. Initially the teachers tended to be more concerned with the substance than with the approach but as they began to master the mathematics, changes in the teaching approach gradually became evident.

E. Copyright

The U.S. Government policy on copyright necessitated putting the textual materials developed in the public domain. This situation while satisfactory in some respects has affected the Program adversely in other respects.

The Program has never felt that it was producing a definitive text for use in all Africans schools in all countries. The texts were considered as a means whereby African ministries of education could observe the suitability of the material for their countries and ability of their teachers to

teach this material. It was expected that at some later date the countries themselves, partly as a result of the training given throughout the Program, would be able to make the necessary changes in the original materials and produce their own texts. As the books were in the public domain it was possible for the African ministries to use the texts in the original form or adapt and change to the extent that they and their advisors thought advisable.

On the other hand when the African ministries began to observe the effect of the new materials and demand the introduction of the materials into more and more classes, the Program was unable to supply the necessary texts. By contractual agreement only 30 class sets could be issued at any grade level in any one country. To permit an expansion of the use of the materials, it was necessary for a commercial publisher to undertake reprintings. As no one publisher could claim copyright on the materials, none was willing to undertake this task.

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RELATIONS WITH AFRICAN MINISTRIES AND THEIR PERSONNEL

A. Problems

As might be expected, the Program found a wide range of interest in the African ministries about mathematics and possible changes in mathematics. In some ministries where there existed an administrator with a strong mathematical background, there was seldom any difficulty in obtaining full cooperation with the Program. In other cases a considerable amount of groundwork had to be laid.

Moreover, when the Program started, some of the countries involved had not yet achieved independence and senior positions in the ministries were still held by expatriates. In a few cases this gave rise to some difficulties, as people who had been involved in setting up existing mathematical programs found these programs under attack from a group of people whom they knew nothing about and who were advocating a type of mathematics which was not known to them. In all cases these difficulties were overcome at least to the extent of the senior officials permitting country involvement in the Program.

A third problem which continued throughout the Program was the constant changing of senior administrative personnel in the ministries. There were occasions when decisions and cooperation which were achieved in one year were threatened by the new official who was not aware of the objectives of the Program.

B. Building up Rapport with African Ministries of Education

The good rapport with ministries which was finally achieved was obtained through many means.

Possibly the most significant activity which won the Program's support in Africa was the six weeks' meeting held at Endicott House in Dedham, Massachusetts in 1961. This meeting was attended by 51 people of whom 16 were African ministry officials and educators. As a result of this meeting, right from the beginning the Program had contacts in senior positions in many African countries. These Africans had already struck up friendly relationships with people connected with EDC, and in particular with Professor J. Zacharias, Vice President of EDC, and Professor W.T. Martin, at that time Chairman of the Mathematics Department at the Massachusetts Institute of Technology. The activities of Professor Zacharias and Professor Martin at Endicott House and at the Accra and Ibadan meetings and in their early travels in Africa did much to create the good feelings which continued throughout the period of the Program.

C. The Steering Committee

The Program benefited greatly in Africa from the strength of the Steering Committee which initially had representation from all the main curriculum development programs in the U.S. This strength was increased by the participation of other mathematicians with international reputations. Two members of the Academy of National Sciences and other well known U.S. authors of mathematical papers and texts have assisted in the preparation of the Entebbe texts. With only one or two exceptions, the Steering Committee Members participated fully in the Program activities, at workshops, at teacher training institutes or visiting classes. Thus they had close contact with African teachers and its members had a real knowledge of classroom needs

and African aspirations. At quite an early date the Steering Committee was reinforced by the inclusion of African mathematicians who through their personal contacts in their local ministries made access to the ministries easy. The African Governments recognized and respected the strength of educational and mathematical knowledge represented in the Steering Committee.

D. Other Considerations

The Program also benefited greatly from EDC's reputation in the educational world. It was known as an activist group which was bringing about significant changes in educational thinking in the U.S. in mathematics, science and social studies. The personnel in the African Mathematics Program also had this wide interest in general education. During visits to ministries not only mathematics was discussed but also problems of curriculum development in other subjects which were of interest in Africa. Thus the personnel of the African Mathematics Program did much to bring about the initiation of the African Primary Science Program and the African Social Studies Program.

E. Participants' Enthusiasm

The rather unexpected enthusiasm which many participants, working at different levels in education, developed for the Program, created in the countries a small core of devotees who were always available to assist in supervising the work of the Program and also in reporting well of its activities to the senior officials in the ministries. As mentioned earlier the participation of university mathematicians in the Steering Committee and also as members of workshops and institutes did much to add to the local prestige of the Program.

F. Visits and Correspondence

The regular visits of the Chairman and Director of the Program to all the ministries involved, soon built up a very good relationship not only with the very senior officials in the ministries but also with those deeply involved in mathematics education. In a Program lasting for several years it is necessary to make contact at many levels to ensure that if personnel are transferred there still will be available people, respected locally, to support the Program. These visits were supported by a voluminous correspondence with many Africans in many countries. The visits and correspondence resulted in the building up of very real friendships not only by the Americans and Africans involved in the Program, but also between Africans from various countries. There developed a "Pan-African" feeling for the value of the work being done within the Program. Evidence of this was international cooperation in Zambia and Malawi, which in 1965 ran a joint teacher training institute. This was certainly the first occasion in which a joint education effort was made and to the best of our knowledge, the only occasion. Similarly, Sierra Leone and Liberia ran joint institutes in 1964-65 and in 1966 Ghanaian experimental teachers attended a Liberian institute to act as demonstration teachers.

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EVALUATION

The work of the Program has undergone a continuing evaluation by the Steering Committee and an additional objective evaluation was undertaken by the National Science Foundation Committee on International Cooperation in Mathematics Education, at the request of USAID/Washington.

A. Program's Own Evaluation

The Program's own evaluation was obtained by four methods:

1. Reports from Africa by African supervisors of the experimental classes;
2. Tests;
3. Completion of evaluation questionaires by African teachers using the materials;
4. Visits of members of the Steering Committee and U.S. teacher training institute lecturers to African classes.

1. Supervisors' Reports

In all countries the experimental classes were supervised by Africans. This supervision was undertaken by Ministry personnel, some of whom were participants at the workshops, and by African university mathematicians, who were involved either as Steering Committee members or as workshop participants. These supervisors, in the first place, reported to their ministries on the suitability of the materials and the ability of the teachers to use the materials. They were also required to report on the classroom experiments at the opening sessions of the workshops. In one country this local supervision was guided by the ministry's Mathematics Advisory Committee; in another the supervision was controlled by a Curriculum

Development Center; and in a third an African university mathematician with good relations within the ministry was responsible. In other cases the supervision was directly undertaken by the ministry through its officers.

The feedback from local supervisors was generally very favorable. There was some minor criticism of the Secondary One and Two volumes, and a more general criticism that the Entebbe Five Year Secondary Course could not easily be used in countries which had a Four Year Course and a severe criticism of the Entebbe Secondary Three Geometry. While the Steering Committee did not fully agree with this latter criticism, the Program reacted positively to deal with all three items.

2. Tests

One of the main activities of the workshops was the creation of tests by a specific testing writing group. These tests were intended to assess the efficacy of the materials in achieving its mathematical aims. Some of the tests developed, Secondary One and Primary Three, were comparative tests and were intended to measure the relative mathematical ability of children who were following the Entebbe course or some other course. Most tests were pretested in two or three countries by the African supervisors. At a later workshop the testing writing group, which for most of the Program was under African chairmanship, reviewed the pretest results and prepared finished tests. The Testing Group also developed specimen examinations for the African Primary Learning Certificates and for the 'O' Level and 'A' Level examinations at Secondary Level.

Master copies of these tests and specimen examinations, twenty-three in all, for classes Standard III through Form V were dispatched to participating Ministries of Education and others with responsibilities for testing. Sets of the tests have also been sent to people inside and outside

Africa who are involved in testing work and who have expressed interest. It is of interest that in two cases, due to local administrative forgetfulness, students who had followed an Entebbe course were required to take external local traditional exams at Primary level. It was very encouraging to the Program and satisfying to the local Ministries that in both these cases, although their additional knowledge of modern mathematics was not tested, the students who had followed the Entebbe course tended to do much better on the traditional exam than did the average examinee.

3. Evaluation Forms

Included in each Teacher's Guide there was a detailed evaluation form which requested specific information regarding the suitability of units within the text and asked for candid criticisms and suggestions for improvement. The Program was no more fortunate than other programs of this sort in obtaining full and detailed replies to these evaluation forms. Nearly 900 were returned. With very few exceptions the comments were either favorable or noncommittal.

4. Visitors' Reports

Whenever possible, the United States Steering Committee members and visiting lecturers to institutes, prior to the workshop, and before and after the institutes took the opportunity to visit classes using the Entebbe materials. The reports on these visits and their discussions with teachers added to the overall knowledge about the use of the materials in the classroom.

As a result of these various forms of evaluation, the need for improvement, change and revision in some of the preliminary editions was recognized. The revisions included Basic Concepts, Volumes 1 and 2, Primary One and the

preparation of a new secondary series known as the 'C' course. This 'C' course was suitable for a four-year secondary program which operated in some of the participating countries and included changes in textual materials resulting from observations, comments and criticisms of the original five-year series.

It was the intention of the Program to undertake a final evaluation of the use of the texts in 1969 through 1971 and to make final recommendations for alterations in presentation and revisions. This plan was presented to USAID/Washington in the progress projection of 1966. Suggestions for a separate evaluation proposal was presented to USAID/Washington in 1966-67. Due to the early conclusion of the research and development aspects of the program and the non-availability of funds, neither of these plans were implemented.

B. Objective Evaluation - National Science Foundation Committee on International Cooperation in Mathematics Education

At the request of USAID, another evaluation was undertaken by the National Science Foundation Committee on International Cooperation in Mathematics Education, independent of the Program. This evaluation assessed the quality of mathematics and content of the texts, the operations of the Program in Africa and the reactions of the African government to these operations.

The report in general was most favorable but did identify some areas in which the Program and USAID were criticized. The texts were considered to be of a very high order. Criticism was made of the rather sudden way in which The Research and Development Program was terminated, so that some of the African Ministries of Education felt that they had been ignored and left without further assistance to implement what they considered the satis-

factory results of the research phase. Criticism was also made of the involvement of African participants in the evaluation and of the failure to involve Africans in the revision process. Severe criticism was leveled at the Program for its failure to ensure that African schools received textbooks as they were needed. On the other hand, the report gave great praise for the impact of the Program on Africa schools, educators and Ministries and on the enthusiasm which had been built up in Africa for its activities.

The Program accepts that some African Ministries and schools had been upset at the conclusion of the research and development phase and of the problems which book distribution had given rise to. On the other hand, all African Ministries were informed fully a year and a half in advance that the Program was drawing to a conclusion and were warned that they themselves should take alternative action such as individual proposals to USAID and other funding agencies for a continuation of the effort. In some ways, the upset was occasioned by their failure to take such action.

Comment has already been made on the problems of book distribution arising from a decision to initiate the classroom trials of materials within five months of the first workshop and difficulties which arose in getting books from publishers into Africa in such a short time. These problems were, of course, compounded by a series of dock strikes in the United States and in Africa. The Program does not however accept that it failed to involve Africans in the evaluation and revision processes. Their involvement is described above and even greater involvement was envisaged in the suggested evaluation and revision which was to take place during 1969 through 1971.

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SUCCESSES AND PARTIAL SUCCESSES

1. Overall View

In terms of our declared aims as listed earlier in this report, the Program can claim quite a considerable amount of success. All the participating countries are now fully aware of the changes taking place in mathematics education in the United States and the United Kingdom. Through the supervision of the experimental classes and the guidance given at the workshops, the teacher training institutes and the ABC Institute, there is now in each country a group of people who have worked with the new materials, who have undergone training and who have tried and observed the use of the new materials in their classrooms. Through activity in the workshops, 102 Africans have participated in the workshops creating curriculum materials, listening to reports on the use of those materials and making decisions concerning revisions.

2. Changes in Teaching Practices

Most African teachers and children who have been involved in the Program have enjoyed the type of classroom activity which in the long term we would consider desirable. However, the traditions of classroom teaching in Africa and the deeply ingrained habits of teaching of the vast numbers of teachers is not likely to be changed quickly. There is evidence, however, that the Program has succeeded in bringing about some change in this direction. A supervisor in Malawi has given some indication how the recommended teaching methods of the Program have affected the classroom teaching. It was reported that because of the recommended teaching approach and the need to involve children in discussions about the mathematics they were learning, the English of these children had noticeably improved.

There is now clear evidence of the involvement of African university mathematicians in decisions in mathematical education policies. In seven out of ten countries mathematicians teaching in African universities are now involved in developing mathematical education policy. Finally, African mathematics educators are now fully aware of mathematical curriculum development in the United States.

3. Involvement

These successes are mainly responsible for the decisions of all the participating countries to implement mathematics education throughout the school systems as soon as personnel and finances are available. Some of these countries are already well along the road to implementation. Tanzania and Ethiopia have carefully drawn up long range plans for implementation which are already beyond the initiation stage. Ethiopia and Kenya and Ghana, Liberia and Sierra Leone are in regional programs to introduce the new mathematics materials into all primary schools. Nigeria despite internal troubles is active in three or four regions and Lagos City has for some years now been organizing courses throughout the year for teachers who are using the Entebbe primary materials. Malawi has been using new mathematics in its training colleges for two or three years. Uganda, after using the Entebbe materials in only two secondary classes, decided that they would use a program based on British texts. Activity at primary level seems to be confined to teacher training colleges. Expansion of activity at the primary school level was impeded by the imposition of a very poor unauthorized adaptation of the Entebbe texts. A similar situation exists in Zambia where once again the training colleges appear to have been deeply involved

with the Entebbe series while the secondary schools are using the British texts and the primary school work has been delayed by an unfortunate local adaptation.

4. Need for Local Supervision

It is worth noting the greatest activity and most obvious success has occurred when the Ministries have appointed one person whether an official or a university mathematician to be responsible for the activity. It is particularly noticeable in Uganda, Zambia, Sierra Leone, Liberia and some of the Nigerian states that the lack of such person has prevented full scale experimentation and supervision even though in some cases there was local enthusiasm for the Program.

5. Delivery of Materials

Administrators and teachers in some schools did have reason to be concerned about the timely delivery of texts, even though on no occasion, having received a request, would the Program ever fail to get materials to a school even if only in duplicated form. One can understand, however, that teachers about to start a school year would become very worried if the texts had not arrived two weeks before the beginning of the school year.

6. Expatriate Problems

Another problem which had some affect on the Program was the natural bias of some expatriate teachers for materials which had originated from their own countries rather than from a Program which although heavily African was based in the United States.

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IMPACT

A. Examinations

Both the East and West Examinations Councils are now offering 'O-Level' examinations suitable for students who have completed the Entebbe Secondary Course. Some countries are now making preparation for a primary leaving examination in mathematics which those who have completed the Entebbe Primary Course will be able to take without discrimination. The Entebbe Primary series is now being used as a base for modern mathematics texts in all countries which participated in the Program with the possible exceptions of Uganda and Zambia. Already Ethiopia, Ghana, Kenya and Tanzania have produced a program-approved preliminary adaptation of the primary texts. In addition other texts which claim to be Entebbe based have been produced in Nigeria, Uganda and Zambia. The remaining countries are still using the original texts.

B. Personnel

A measurement of the success of the Program has been the involvement of Program-connected personnel in the preparation of the adaptations. Moreover, Program participants are now involved either in an advisory capacity or as assistants in teacher training institutes and training colleges which are introducing modern mathematics. All the indications are that these former participants in the workshops, institutes and ABC institutes have developed enthusiasm for mathematics education in its new form which is surviving despite the conclusion of the research and development phase of the original program. Mention has already been made of the impact of the Program on officials of the Ministries of Education to the extent that all Ministries have now officially adopted a policy for the implementation of mathematics curriculum reform throughout their school systems.*

* Appendix III-Excerpt from Lagos State Commissioner of Education Speech

C. International

There is also pretty clear evidence that the Program has obtained favorable notice in the international scene. Requests for information and copies of texts have been received from India, Pakistan, Western Samoa, Puerto Rico, West Indies, Chile, Canada, New Zealand, Rumania, Israel, Lebanon, Guyana, Brazil, Malaysia, Australia, United Kingdom, Argentina, Belgium, Spain, Indonesia, Philippines* none of whom are participating countries. It is clear from the nature of many of these inquiries the Entebbe series is being used as a resource for the development of other curriculum materials in mathematics in these countries. Particular mention must be made of the Mariana Islands which, as a result of the review of the Entebbe Mathematics Series, is now involved in adapting the series for use in the Islands. Two adaptations have been published by SRA, Chicago for use in the United States; and Associated Publishers Pte. Ltd., Singapore, is presently adapting the secondary series for use in Singapore.

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* Appendix IV - Interest in Entebbe Texts Outside Africa

and funds. One cannot rely on teachers' reports on the use of materials and there appeared to have been occasions when the local supervisors either did not recognize weaknesses in the materials or were unwilling, through diffidence or fear of upsetting susceptibilities, to report on the weaknesses.

3. African Attitude to Long-Term Research

One also has to question the willingness of underdeveloped countries to go through a seven-year research and development effort. In the African Mathematics Program it was already clear in the fourth year that some of the Ministries were sufficiently satisfied with the materials and were ready to take the first steps toward implementation. In underdeveloped countries where the materials and methods used in the schools are usually poor and tied to teaching practices of 20 or 30 years ago, any reasonably good program is quickly recognized as an improvement and the countries are unwilling to await the completion of the research on a full detailed evaluation so well liked by research officers. It is a danger that those coming from developed countries seek a greater perfection than is possible in countries which start at such a low level and one has to consider the possibility that a step-by-step improvement based on local conditions has to be used before a completely satisfactory program can be achieved.

4. Vocational Education

The program did not give any serious considerations to vocational education or the integration of mathematics and science education. As only ten per cent of primary school leavers move on to secondary education, questions may be asked if the primary texts have a sufficient rural and vocational guidance. At the beginning of the program, the

African Ministries considered their primary schools mainly as recruiting places for secondary education. This situation has now changed. However, the primary texts are related very closely to the environment and do, we believe, prepare the African child who leaves school for the world he will be living in. They also prepare him for any academic course or vocational course he may later follow. These are arguments against doing much more than this at primary level.

The program itself did not prepare any vocational courses at post primary level. This is a task still to be done and should probably be done by those with a specific knowledge of the vocation for which training is being given and by mathematicians who can recognize the full mathematical implications of the mathematics used.

5. Integration of Mathematics and Science

In 1962 real primary science education in African schools was practically non-existent. Perhaps it would have been possible to undertake a joint mathematics/science curriculum development program which would have insured satisfactory integration. At that time it certainly did not seem possible because of the existing state of primary science and primary mathematics education and of the teaching approaches then practiced by teachers in the schools. Indeed at that time, and even today, very little has been done in the United States in this area. The African situation has now changed. The work of the African Primary Science Program has produced a new climate. What seemed impossible in 1962 now seems probable in 1971. The new science programsbeing developed in Africa are seeking areas for integration and African mathematics educators recognize the desira-

bility of such integration. Even now, however, due to examination pressures, it is very difficult to initiate an integrated Math/Science course at Secondary level.

6. Leadership Training

There were indications in countries where the Program was less effective that one may need to develop at a very early stage the necessary local personnel to undertake leadership. In places where reliance was put on one person either inside or outside the Ministries, it was possible and indeed probable over any extended period of years that the activities would be very seriously affected by the transfer of that person or the development of local enmities against him. This would suggest that the Program would have benefited greatly if the Ford-funded ABC Institute Program had been initiated three or four years earlier.

If such had indeed happened, it would have been possible to undertake at a much earlier stage a full and proper teacher training program which the Program now feels should be begun as early as possible.

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CONCLUSION

Two new regional programs for the implementation of mathematics curriculum reform in Ethiopia and Kenya, and Ghana, Liberia, and Sierra Leone have been funded. The principal aim will be the preparing of the mathematics tutors in training colleges and supervisors of schools will be ready to guide and advise and run inservice training courses for the teachers in the schools. It must be realized that the introduction of a structured curriculum is necessary in mathematics and entails the mathematical re-education of all teachers in the schools so that as the children move up in the school or are transferred from one school to another, they will be following the same reform syllabus. This retraining of teachers is not a short-term program and may take five to ten years. The main purpose of the Regional Programs is to ensure that personnel will be available to undertake such retraining.

Finally, we would like to take this opportunity to express our deep appreciation of the cooperation, encouragement and funds which we have received from The Research and Analysis Division of USAID/Washington and from the education advisers in the African Division of USAID/Washington and in the field. Without such sympathetic understanding and educational help, the Program could not have achieved its present success.

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APPENDIX I

AFRICAN MATHEMATICS PROGRAM STEERING COMMITTEE

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*Professor W. T. Martin
Massachusetts Institute of Technology
Cambridge, Massachusetts

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Ahmadu Bello University
Zaria, Nigeria

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Education Development Center
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Education Development Center
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Franklin and Marshall College
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Northern Illinois University
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Kumasi, Ghana

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East Lansing, Michigan

Mr. Yohannes Menkir
Haile Selassie I University
Addis Ababa, Ethiopia

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West African Examinations Council
Yaba, Lagos, Nigeria

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Makerere University College
Kampala, Uganda

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Williams College
Williamstown, Massachusetts

Professor Patrick Suppes
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Dr. Onyerisara Ukeje
University of Nigeria
Nsukka, Eastern Nigeria

Mr. Stephen White
Alfred P. Sloan Foundation
New York City

* Dr. Awadagin Williams
University of Sierra Leone
Freetown, Sierra Leone

Dr. Grace Alele Williams
University of Lagos
Lagos, Nigeria

Professor Jerrold R. Zacharias
Massachusetts Institute of Technology
Cambridge, Massachusetts

* Executive Committee Members

APPENDIX II

Excerpt

from

a report by

Professor Vincent Haag (Franklin & Marshall College)

on

The Mid-West Nigerian Institute 1967

" ...This observer was even more pleased with the fact that the primary phase of the Auchi Institute provided an existence proof that the objectives of the E.S.I. African Programme can be met. Here was an example of a local mathematician and educator (Dr. Williams) organizing and conducting a teacher training institute for primary teachers with the help of local tutors (the ABC people). (The American lecturer devoted most of his time to the secondary teachers and was not needed for the primary program.) In other words, here was a training programme, as successful as any this writer has seen in Africa, organized and manned entirely by local representatives of the E.S.I. venture.

It should be added here that the ABC people were surprisingly competent in their roles as tutors (surprisingly, because one never ordinarily sees local people at this educational level with such sound mathematical sense.) After watching these ABC people at work and after conversations with them it was evident that their experiences in the ABC programme in Nairobi last summer made the difference, and that the whole concept of the ABC Programme has already begun to pay dividends."

APPENDIX III

Excerpt

from

An Address By

The Lagos State Commissioner

for Education and Community Development

"...The course was sponsored by the Educational Development Centre of Newton, Massachusetts in the United States of America and the University of Ibadan. A small contingent of School Inspectors and Headmasters from Lagos attended the Institute. On their return, they initiated the teaching of modern mathematics into eight primary schools in Lagos City. This experiment was undertaken by the Primary School Section of the Federal Ministry of Education."

"...As it happened, experiments similar to what was going on in Lagos were being conducted at the Primary and Secondary School levels in other parts of Nigeria as well as in nine other English speaking African Countries. The main objectives of the experiment were to train teachers in basic concepts of elementary mathematics and to lead them to familiarize themselves with new and meaningful ways of assisting children to mathematical discovery. With the continuing experiment in the different countries, however, the need to train Inspectors to conduct their own national In-Service-Training and Tutors to introduce the new approach in their own Teacher Training Colleges became obvious and imperative.

Accordingly, in July, 1966 Tutors were chosen from Lagos to participate in a three-year In-Service programme that would enable them to promote the teaching of modern mathematics in their own schools and Teacher Training Colleges. This in-service course was held in Nairobi and gave opportunity

for our tutors and inspectors to improve their mathematical competence as well as meet others in the same profession. These Tutors and Inspectors have been the back-bone of the annual mathematics seminars held for teachers in Lagos since 1966. With their assistance the Lagos City Council Education Department working jointly with the Federal Ministry of Education (Primary Section) have been able to increase the number of schools and thus the number of pupils and teachers participating in this experiment to improve the teaching and learning of mathematics. Whereas in January 1965, we had only eight schools with sixteen classes of forty-five children each, participating in the experiment, the annual mathematics seminars as well as the fortnightly meetings organized for the teachers had led to much competition amongst headmasters and schools to be included in the experiment. Thus whereas in 1965 we maintained that only one arm of any class should be permitted to experiment with the modern mathematics programme, parents forced us to reconsider our stand and in some schools petitions have made it imperative to have as many as sixteen arms of Primary One included in the programme. By 1968 we had over fifty schools and as many as eight hundred classes of about forty-five children each actively engaged in the experimental modern mathematics classes. Incidentally, the September 1968 Seminar was significant because the number of teachers that offered to participate in the course had to be limited to 250 - although 600 applied to attend the course. By the end of last year, the teaching of modern mathematics had gained wide popularity and the assembly of teachers at his course is a confirmation of this fact. But perhaps much more significant is the clamour of parents to have their children enrolled only in the experimental schools like St. Jude's and only in modern mathematics classes."

"With the assistance of Educational Development Centre, we had for eight months a young man from Yale University in the person of Mr. Stephen

Sidney. Dr. Grace Williams and Mr. Sidney working under the auspices of the Lagos City Council Education Department worked out a programme whereby leading teachers capable of conducting seminars for their fellow teachers were invited to participate in a course. Thus we are now almost in a position to boast of a cadre of teachers and instructors who have sound mathematical knowledge and increased teaching competence."

APPENDIX IV

Interest in Entebbe Texts Outside Africa

USAID Mission to Nepal
Kathmandu, Nepal

State Institute of Science Education
Rajasthan Udaipur, India

Ministry of Education
Singapore

University of Poona
Poona, India

College of Arts, Science and Technology
Bambili, P. O. Bamenda
West Cameroon, Africa

Teacher Training College
Leifiifi, Apia
Western Samoa

Guanabanas School
Aquada, Puerto Rico

Professor Blakers
University of the West Indies
St. Augustine, Trinidad
West Indies

Universidad De Chile
Antofagasta, Chile

The University of Western Ontario
London, Canada

Director of Education
Education Department
Rarotonga, Cook Islands
New Zealand

Department of Education
Wellington, Cook Islands
New Zealand

Mr. Tiberiu Roman
Bucuresti, Romania

District School
Emek Bet Shean, Israel

Kibbutz Lavee
Lower Galilee, Israel

UNRWA - Mousaitbeh Quarter
Beirut, Lebanon

The University of Guyana
Georgetown, Guyana
South America

Companhia Siderurgica
Sao Paulo, Brazil

Ministry of Education
Kingston, Jamaica

Strong Interest

Dr. Jose Vicente Alvarez
Editorial Norma
Cali, Colombia

Director of Education
Education Department
Sabah, Malaysia

Ministry of Health, Education and Labor
Department of Education
Gaberones, Botswana

Regional Headquarters
Education Department
UNESCO/UNICEF
Teacher Training Project
Hargeisa, Somali Republic

Hlotse Secondary School
Leribe, Lesotho

Teacher Training College
Serowe, Botswana

Teacher Training College
Francistown, Botswana

The University of Botswana, Lesotho
and Swaziland
Department of Mathematics
Roma, Lesotho

Teacher Training College
Lobatsi, Botswana

St. Catherine's Training College
Maseru, Lesotho

Seepapitso Secondary School
Kanye, Botswana

Mr. K. E. Barter
Adelaide, Australia

Mr. E. L. Thomas
Shelf, Near Halifax
Yorkshire, England

The Moraitis School
Psychiko
Athens, Greece

Education Extension Center
Wahdat Colony
Lahore, Pakistan

Department of Mathematics
University of Chile
Antofagasta, Chile

Professor Angel Hernaiz
Consejo Nacional De Investigaciones
Cientificas Y Tecnicas
Buenos Aires, Argentina

Mr. Fred Muna
Office of the Educational Administrator
Saipan, Mariana Islands

Mrs. Lynne Nada
Office of the High Commissioner
Saipan, Mariana Islands

Requested Inspection Sets

University of Malaya
Kuala Lumpur, Malaysia

Mr. Surya Sunder Bahuja
H. No. 235 Punjabi Mohalla
Farash Bazar Shahdara
Shahdara - Delhi, India

Z. P. High School
Guntur District, India

Ministry of Education
Maseru, Lesotho

Mr. Jean Houbart
Rijksnormaalschoolen
Tongeren, Belgium

Mr. G. V. Paps
Inner London Education Authority
Uganda

Dr. Julian B. Caparros Moreta
Director
C.I.M.P.
Canary Islands, Spain

Brian Monckton
Chislehurst, Kent, England

Institute of Education
Lahore, West Pakistan

Department of Education
University of the West Indies
Jamaica, West Indies

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Chairman
Associated Publishers PTE, Ltd.
Singapore, Malaya

Ali Asghar Mohajer
Director
Franklin Book Programs, Inc.
Tehran, Iran

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Department of Education
Mbabane, Swaziland

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Ministere de L'Education Nationale
Kinshasa, Congo

University Institute of Education
Oxford, England

Institute of Education Library
Hull, Yorkshire, England

Father C. van Uden
Hatten, Holland

The Association of Teachers of
Mathematics
Urmston, Lancashire, England

Mr. Marcel Desnadryl
European School
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